Complexity and creative capacity: reformulating the problem of knowledge transfer in environmental management

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COMPLEXITY & CREATIVE CAPACITY:
REFORMULATING THE PROBLEM OF KNOWLEDGE TRANSFER
IN ENVIRONMENTAL MANAGEMENT

by

Kelly Chapman

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy (Environmental Management)

Edith Cowan University

Faculty of Computing, Health and Science

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ABSTRACT

The Ningaloo Reef is Australia’s largest fringing coral reef and an iconic tourist destination; however tourism development in Ningaloo has been ad hoc and the area is challenged by human pressure on numerous fronts. In response to these challenges a number of research agencies brought together a range of scientists to study the effects of human interaction on the reef. Moving from research to practice has been understood to depend on the adaptive capacity of the institutions responsible for governing human activities, in this case in the Ningaloo area. Knowledge transfer describes the suite of strategies used to try to bridge the gap between research and management. Knowledge transfer efforts, however, seldom have the desired impact of seeing research applied to decision-making. The ubiquity of knowledge transfer difficulties across disciplines suggests a common root to the problem, based in our shared cultural assumptions. This study pairs a multidisciplinary theoretical investigation with action research to shed light on why knowledge transfer efforts so often fall short in terms of seeing research applied to practice.

Recent environmental management perspectives on knowledge transfer illustrate the shift towards stakeholder participation as a means of improving knowledge transfer success. As such, the action research study involved the researcher embedding herself in the Ningaloo community for 18 months, adopting the role of a knowledge broker and engaging and collaborating with modelling researchers and local stakeholders on knowledge transfer efforts. However, despite intensive stakeholder engagement, evaluation interviews at the end of the process indicated that although the knowledge transfer process had the effect of catalysing relationships between stakeholder groups in the region, and between regional stakeholders and scientists, it appeared to have relatively little effect on the representational knowledge of local stakeholders or the actual application of research in practice. This led to the question of whether knowledge transfer is itself part of the research uptake problem, as per the principles of problem formulation, which specify that resolving seemingly intractable problems requires examining the assumptions that underpin our thinking about the problem situation.

On this basis, the theoretical component of this study explored the Newtonian assumptions that inform our understanding of knowledge transfer. An alternative complexity-based ontology is proposed, unifying the metaphysics of materialism and idealism, based on a synthesis of process philosophy, mathematical logic, quantum theory, general systems theory and the complexity sciences. The phenomena of cognition, learning, knowledge and organising are compared in relation to how they’ve been understood within the Newtonian paradigm, and how they are now being explained from the perspective of a complexity-based paradigm. By reframing the action research results from a complexity perspective, the Ningaloo knowledge transfer process does not constitute a failure in terms of enhancing the capacity of the Ningaloo system to make more sustainable decisions. Rather, the increased connectivity between stakeholder groups and scientists can be viewed as more importantly enhancing the creative capacity of Ningaloo’s governance system. It is posited that the research uptake problem should be reformulated from the basis of complexity paradigm, and the notions of knowledge transfer and adaptive capacity reconceptualised accordingly. Instead of devising rational objective arguments for someone else to improve the ‘adaptive capacity’ of human systems, scientists should focus instead on improving their own creative capacity in their local interactions.
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The Use of Thesis statement is not included in this version of the thesis.
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Signed by Kelly Chapman……... this 31st day of October 2013.
First and foremost, many thanks to the people who took time out of their busy schedules to meet with me and provide their valuable input for this study, who are too many to list. Thanks to CSIRO and ECU for funding this project, and to the Ningaloo Turtle Program, DEC Exmouth and the Exmouth GDC for providing me with office space. Thank you also to the Ningaloo research program’s management coordination committee, for allowing me to attend their meetings and giving this project their active support. Special thanks to all those who opened up their homes and offered me places to stay while I conducted my research, notably Milton Landon, Lyn Irvine, Susie Bedford, Paul Richardson, Peter Dellar, Kylie West, Colleen Sims and Karen Hattingh. I also extend my appreciation to the many people who gave me encouragement, moral support and friendship along the way, among them my supervisors Pierre Horwitz, Pascal Scherrer and Geoff Syme; my collaborators Tod Jones, Beth Fulton, Karen Thompson and Fabio Boschetti; Scott Gardner and Annabel Mazzella, for your ongoing support and ideas; my partner in kiting, Tania Knight; my wonderful climbing friends in Perth; my ‘re-discovered’ family and friends at the Lake; and my long-neglected Canadian friends and family—thanks for sticking with me through this process. Thanks also to Tina Holgate for the onerous task of editing the document. And finally, eternal gratitude to Chris and Patricia for illuminating the path.

This thesis is dedicated to the memory of
Ken and Betty Chapman
and
Chris Keyes
“First there was Chaos, the vast immeasurable abyss, 
Outrageous as a sea, dark, wasteful, wild”

—Milton, Paradise Lost (1668)
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<tbody>
<tr>
<td>AIMS</td>
<td>Australian Institute of Marine Science</td>
</tr>
<tr>
<td>BAC</td>
<td>Baiyungu Aboriginal Corporation</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific &amp; Industrial Research Organisation</td>
</tr>
<tr>
<td>CU</td>
<td>Curtin University</td>
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<tr>
<td>DEC</td>
<td>Department of Environment &amp; Conservation</td>
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<tr>
<td>ECU</td>
<td>Edith Cowan University</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>GDC</td>
<td>Gascoyne Development Commission</td>
</tr>
<tr>
<td>MSE</td>
<td>Management Strategy Evaluation</td>
</tr>
<tr>
<td>MU</td>
<td>Murdoch University</td>
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<tr>
<td>NCC</td>
<td>Ningaloo Collaboration Cluster</td>
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<td>NRP</td>
<td>Ningaloo research program</td>
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<tr>
<td>NSDC</td>
<td>Ningaloo Sustainable Development Commission</td>
</tr>
<tr>
<td>NSDO</td>
<td>Ningaloo Sustainable Development Office</td>
</tr>
<tr>
<td>UWA</td>
<td>University of Western Australia</td>
</tr>
<tr>
<td>WAMSII</td>
<td>Western Australian Marine Science Institution</td>
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PART I: INTRODUCTION & APPROACH

"Everything should be made as simple as possible, but not simpler."
—Albert Einstein

After I had addressed myself to this very difficult and almost insoluble problem, the suggestion at length came to me how it could be solved with fewer and much simpler constructions than were formally used, if some assumptions (which are called axioms) were granted me. They follow in this order:

1. There is no one center of all the celestial circles or spheres.
2. The center of the earth is not the center of the universe, but only of gravity and of the lunar sphere.
3. All the spheres revolve about the sun as their mid-point, and therefore the sun is the center of the universe.
4. The ratio of the earth's distance from the sun to the height of the firmament is so much smaller than the ratio of the earth's radius to its distance from the sun that the distance from the earth to the sun is imperceptible in comparison with the height of the firmament.
5. Whatever motion appears in the firmament arises not from any motion of the firmament, but from the earth's motion. The earth together with its circumjacent elements performs a complete rotation on its fixed poles in a daily motion, while the firmament and highest heaven abide unchanged.
6. What appears to us as motions of the sun arise not from its motion but from the motion of the earth and our sphere, with which we revolve about the sun like any other planet. The earth has, then, more than one motion.
7. The apparent retrograde and direct motion of the planets arises not from their motion but from the earth's. The motion of the earth alone, therefore, suffices to explain so many apparent inequalities in the heavens.

"I fully agree with you about the significance and educational value of methodology as well as history and philosophy of science. So many people today—and even professional scientists—seem to me like someone who has seen thousands of trees but has never seen a forest. A knowledge of the historic and philosophical background gives that kind of independence from prejudices of his generation from which most scientists are suffering. This independence created by philosophical insight is—in my opinion—the mark of distinction between a mere artisan or specialist and a real seeker after truth.”

—Albert Einstein

1.1 Introduction

The Ningaloo Reef is Australia’s largest fringing Coral Reef, extending across 300 kilometres of coastline between Exmouth and Carnarvon. In 2001, the State Government recommended the nomination of the Ningaloo Marine Park for World Heritage listing. The area is now widely marketed as one of Western Australia’s premier tourism destinations (Western Australia Planning Commission 2004) and, given the area’s unique natural attractions, visitor numbers have increased substantially since the 1990s (Wood & Dowling 2002), with over 100,000 people visiting the region annually (Carlsen & Wood 2004; Northcote & Macbeth 2008a).

Tourism development in Ningaloo has been somewhat ad hoc to date (Wood 2003) and as such the social, ecological and economic sustainability of tourism in the area is being challenged on numerous fronts by over-burdened infrastructure, waste generation, high impact developments, effects on visitor experience, site erosion, fishing pressure, resistance to enlarged marine sanctuary zones, accommodation shortages and crime (Northcote & Macbeth 2008a, 2008b; Western Australia Planning Commission 2004).

In response to these challenges, the Ningaloo Collaboration Cluster (NCC) and the Western Australian Marine Science Institute (WAMSI) brought together scientists and expertise from a range of disciplines with the goal of describing, understanding and modelling the processes of human interaction with Ningaloo Reef. The aim of this Ningaloo research program (NRP) is to develop systems to explore different management scenarios for the region that sustain the ecological integrity of the area (CSIRO undated). For example, the Ningaloo Tourism Futures project—one of five projects in the NCC—worked with stakeholders to explore different futures that may be achieved by employing different regional strategies using futures modelling (Jones 2007).

Moving from research to practice (actually using research to make more sustainable decisions) depends on the adaptive capacity of the institutions responsible for governing human activities in the Ningaloo area. Adaptive capacity can be framed as the collective ability and willingness of institutions to use research and modelling feedback to influence their decisions. However, the literature indicates that despite careful research, modelling and planning, resource management recommendations in complex social and ecological systems, such as those being proposed for tourism in Ningaloo, often fail to deliver as expected on the ground (Medema et al. 2008).

Bridging the research-management gap in ways that foster continuous learning among both individuals and institutions is one of the greatest challenges to global sustainability (Laszlo & Laszlo...)

---

1 The Ningaloo Collaboration Cluster is a major research project that commenced in the region in 2007, involving researchers from the CSIRO, Sustainable Tourism Cooperative Research Centre and a range of Australian Universities including Curtin University of Technology, Murdoch University, University of Western Australia, Australian National University and the University of Queensland.

2 Henceforth collectively referred to as the Ningaloo research program or NRP.
Chapter 1

Knowledge transfer is the term used to describe the suite of strategies used to try and bridge this gap. In Australia, several hundred publicly-funded organisations are engaged in the generation of scientific knowledge in natural resource management (Campbell & Schofield 2007). Scientists are now under considerable societal pressure to share their knowledge and see that research is used (Lovejoy 2009), and many researchers working on environmental issues have called for stronger linkages between science and policy (Brown 2003; Lomas 2000; Mitchell & Lankao 2004; National Research Council 1999). Yet despite this imperative, knowledge transfer efforts frequently fail to have the desired impact on how we make decisions and manage our resources.

So why is it that efforts to improve research uptake by management so often fall short? Some scholars in the environmental management field believe that scientists are not producing information that is sufficiently useful to decision-makers (e.g. McNie 2007). Others suggest that linkages between scientists and managers need to be strengthened through engagement and collaboration (e.g. Roux et al. 2006), or through knowledge brokering (Michaels 2009). Research on the problem of linking science and decision-making is lacking, however, and trialling new approaches to narrowing the research-implementation gap is needed. As such, this study began as an action research study, informed by the knowledge transfer literature in the environmental management field. For the study, I adopted the role of a knowledge broker to participate in the knowledge transfer efforts between the NCC and stakeholders in the Ningaloo region and to document its outcomes. It was hoped that the action component of this study would help improve the impact of $36 million of research on regional decision-making.

However, as the action research study progressed, I became concerned that the conceptual framework I had derived from the environmental management literature was somehow flawed, and that our knowledge transfer efforts were not going to have the hoped-for effect. I decided to undertake a detailed theoretical investigation to serve as a companion piece for shedding light on the outcomes of the action research study. The National Research Council (1999) suggests that those in the natural sciences have not sufficiently recognised the contributions social and behavioural sciences can make to understanding knowledge transfer. With this in mind, I conducted a review of the social sciences literature to gain a better understanding of how individuals and organisations create, share and act on knowledge. Although this generated some useful insights, I also found that business management scholars (e.g. Burnes 2005) were reporting knowledge transfer failure at rates similar to those in the environmental literature. The ubiquity of knowledge transfer difficulties across disciplines suggested a common root to the problem, one based in our shared and deeply held cultural assumptions. This led me to further expand my theoretical investigation into the history of Western science and philosophy, in order to uncover our deeply held assumptions about the nature of reality and knowledge. During my reading, I found that some business management scholars are now looking to complexity theory for a new set of assumptions to explain learning, knowledge and behaviour, in both individuals and organisations (e.g. Shackley et al. 1996; Stacey et al. 2000). Thus I also undertook a review of the complexity sciences, to gain a better understanding of how complex systems emerge and behave.

In this thesis, I synthesise the results of this theoretical investigation and action research study to devise a new conceptual framework for understanding knowledge transfer in environmental management. It is anticipated that this framework will provide new insight into why knowledge transfer efforts so often fail, and how scientists can improve the management impact of their research.

In this introductory chapter, I outline the study’s significance, purpose and research questions. I also rationalise the need for the study by reviewing the adaptive capacity concept and its role in maintaining resilient socio-ecological systems, and by outlining the critical success and failure factors associated with building adaptive institutions as commonly identified in the environmental management literature. I then introduce the role of knowledge transfer in building adaptive capacity, and touch on selected organisational learning, knowledge management and ‘complexity thinking’ concepts from the social sciences literature. These topics will be dealt with in greater detail in the chapters that follow. From this review, I define a loose conceptual framework and core assumptions that informed this study at its outset.
1.2 Significance & Purpose

This study is of importance in that it will fill knowledge gaps and explore methodologies that are crucial to improving research uptake, particularly in relation to large research programs aiming to have management impact. In particular, the proposed research is of national and international significance to environmental researchers and managers in that it will:

- Synthesize understandings of the barriers and opportunities associated with knowledge transfer and building adaptive institutions, as documented in the environmental management literature;
- Make a significant knowledge contribution to our understanding of knowledge brokering in a collaborative multi-agency knowledge transfer process, including its effects on the knowledge, perspectives, behaviours and relationships of both stakeholders and researchers;
- Synthesize findings from the social science and complexity science literature to provide a new conceptual framework for advancing our understanding and application of knowledge transfer in environmental management, particularly in relation to building adaptive institutions;
- Help address the needs and aspirations of researchers, policy makers, resource managers and community members dealing with development and visitation pressures in one of Australia’s iconic tourism destinations, by explicitly combining research with practice.

This study is innovative in that it generates a new conceptual framework for understanding knowledge transfer in environmental management. It is also innovative in that it describes phenomena resulting from a collaborative knowledge transfer process, not only from the perspective and values-platform of the researcher and environmental manager, but also that of a cross-section of community members and agency staff who live and work in the study area.

The purpose of the action research component of this study is to describe the nature and effects of knowledge transfer between the NRP and stakeholders in the Ningaloo region (with special attention to the role of knowledge brokering), in relation to a conceptual framework devised from the environmental management literature. The purpose of the interdisciplinary theoretical investigation is to shed light on why knowledge transfer efforts in the environmental field so often fall short. In doing so, it develops a new conceptual framework for understanding and applying knowledge transfer to build adaptive capacity. In line with its purpose, the following research questions specifically guided this study:

1. What are the critical success and failure factors associated with knowledge transfer and building adaptive institutions, as commonly identified in the environmental management literature?
2. What were the barriers to and opportunities for knowledge transfer in the Ningaloo region as perceived by stakeholders?
3. What knowledge transfer processes emerged through the course of the study, and how did they affect the knowledge, perspectives, behaviours and relationships of various stakeholders?
4. How effective was the knowledge transfer process from a stakeholder perspective?
5. How can the social sciences, philosophy and complexity theory contribute to our understanding of knowledge transfer in environmental management?
6. How can these results contribute to a new framework for using knowledge transfer to help build adaptive capacity in socio-ecological systems?

For the purposes of this thesis, the term ‘stakeholder’ will be based on Freeman’s (1984) definition, and will refer to any group or individual who can affect, or is affected by, the achievement of the aim of the Ningaloo research program (NRP), that being to generate knowledge and tools (e.g. models, atlas, etc.) that will be used by managers to make well-informed decisions about the Ningaloo Marine Park and the region. As such, researchers are also considered stakeholders in this study.
1.3 Study Rationale

It is now widely accepted that ecological and social systems are complex, inter-connected, non-linear and unpredictable entities that cannot be understood from a single perspective or discipline (be it ecological, economic or social) or abstracted from their historical, social, political or landscape contexts (e.g. Funtowicz & Ravetz 1993; Meppem & Bourke 1999). For example, Farrell and Twining-Ward (2005) argue that the environment and tourism should be viewed as complex and integrated social-ecological systems, subject to notions of ecological resilience and adaptive capacity, as widely referred to in the sustainability literature (e.g. Gunderson & Holling 2002; Gunderson et al. 1995; Holling 1978).

The complexity and unpredictability of ecological and social systems clearly present substantial challenges for today’s resource managers, who must make difficult decisions based on incomplete information in an uncertain world. In such environments, resource managers are faced with so-called ‘wicked’ problems. Wicked problems are complex socio-environmental problems that span multiple systems, disciplines and worldviews. They are impossible or difficult to solve because they cannot be singularly defined, they do not have right or wrong solutions (just better or worse as subjectively defined by involved stakeholders), they have numerous subjective causes, and implemented ‘solutions’ have significant consequences, meaning there is no opportunity for trial and error learning (Rittel & Webber 1973).

Conventional scientific/technical approaches to resource management based on linear causality and reductionism have neglected the agenda of social change which parallels the process of defining environmental problems (Allen 2001; Hajer 1995; Meppem & Bourke 1999), instead emphasising the more easily dealt with technical and scientific aspects (Kay & Alder 1999). Meppem and Bourke (1999) argue that this reliance on ‘technofix’ rather than social approaches to environmental problems has resulted in impotent politics, ineffective environmental policy, and an inoperable concept of sustainability. Centralized institutions using linear models and mechanistic views of nature to increase resource production and efficiency have eroded the variation and resilience of natural systems, making them vulnerable to crisis (Gunderson & Pritchard 2002; Holling & Meffe 1996). Folke et al. (2003) suggest that conventional science and management are unable to deal with these ‘wicked’ complex systems problems, and that new approaches are needed, such as adaptive management.

Walker et al. (2002, p.6) define resilience as “the potential of a system to remain in a particular configuration and to maintain its feedbacks and functions, and involves the ability of the system to reorganize following disturbance-driven change.” As such, ‘resilience’, as applied to ecosystems and socio-ecological systems, has three defining characteristics:

- the amount of change the system absorbs while still retaining the same controls on function and structure;
- the degree to which the system can self-organize;
- the ability to increase the capacity for learning and adaptation (Walker et al. 2002).

Systems with high adaptive capacity are able to re-configure themselves without significant losses in critical functions, such as primary productivity, hydrology, or socio-economic health (Folke et al. 2003). The adaptive capacity of ecological systems is linked to genetic, biological and landscape diversity (Bengtsson et al. 2003; Carpenter et al. 2001; Peterson et al. 1998). The adaptive capacity of social systems, on the other hand, is linked to the presence of flexible and long-enduring institutions that respond to challenges by experimenting, learning, problem solving, and balancing the interests of various stakeholder groups (Scheffer et al. 2000; Walker et al. 2002).

A consequence of losing resilience, and therefore of adaptive capacity, is the reduced ability to deal with change because of there being fewer options for renewal and reorganization after periods of disturbance or crisis (Folke et al. 2003). Folke et al. (2003) identify four critical factors needed for dealing with changing natural resource dynamics:
learning to live with change and uncertainty;
• nurturing diversity for resilience;
• combining different types of knowledge for learning; and
• creating opportunity for self-organization towards social-ecological sustainability.

1.3.1 Building Adaptive Institutions: Critical Success and Failure Factors

1.3.1.1 Adaptive Management

One approach that can embody the factors noted above is adaptive management. Adaptive management is a framework through which research, policy and local practice can be integrated to increase the adaptive capacity of systems through cyclical learning and policy adjustment and implementation (Gunderson & Holling 2002; Gunderson et al. 1995; Holling 1978; Medema et al. 2008; Walters 1986). Holling (1978) describes adaptive management as “an integrated, multidisciplinary and systematic approach to improving management and accommodating change by learning from outcomes of management policies and practices.” Thus it is a tool for both changing and learning about a system. This approach allows testing of key hypotheses about the system by comparing the outcomes of different policies and practices (Holling 1978; Lee 1999; Walters 1986). Berkes et al. (2003) note that adaptive management is founded on social and institutional learning using feedback from the environment to shape policy, followed by experimentation to further shape subsequent policy (e.g. Figure 1.1). This iterative process is “based on feedback learning…involving two-way feedback between management policy and the state of the resource, leading to self-organization through mutual feedback and entrainment (Berkes et al. 2003, p.9, citing other authors). In sum, sustainable governance of socio-ecological systems requires learning, experimentation and iteration.

Figure 1.1. Adaptive management cycle outlined by CMP’s Open Standards Project (source: Conservation Measures Partnership 2007).

1.3.1.1 Features of Adaptive Institutions

Because adaptive management requires the integration of disciplinary knowledge, realization of the benefits outlined above requires an inclusive multi-stakeholder approach throughout the entire adaptive management process (Dovers & Mobbs 1997; Holling 1978; Shindler & Creek 1999;
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Walters 1997). Because of this, adaptive management is very much a social as well as scientific process, requiring institutional flexibility and innovation as well as the formation of new institutions (Holling 1978; Walters 1997).

Institutions can be defined as the constraints developed by people to shape their interactions and the evolution of their societies through time (North 1990). Institutions are comprised of both formal and informal constraints, the former being rules, laws, policies, etc., the latter being norms, conventions, etc. Institutions have the capacity to both enhance and inhibit feedback links and between society and the environment. Where they enhance feedback links, they increase adaptive responses and prospects for long term sustainability (Hanna et al. 1996). Where they inhibit feedback links, they reduce adaptive responses and social and ecological resilience (Folke et al. 1998).

Young and Underdal (1997, cited in Folke et al. 2007) state that the “effectiveness and robustness of social institutions are functions of the fit between the institutions themselves and the biophysical and social domains in which they operate.” The literature identifies a number of features that characterize institutional arrangements with high adaptive capacity. Firstly, adaptive institutions must be flexible, capable of self-organization and willing to embrace change and experiment (Blann et al. 2003; Folke et al. 2003; Gunderson 2003; Seixas & Berkes 2003). They need the ability to understand and shift complex system relationships by monitoring and testing management actions in iterative adaptive management cycles (Folke et al. 1998). Modelling is a useful tool for understanding the behaviour of complex systems and selecting between competing management options and hypotheses (Gunderson 2003; Norton 2005; van den Belt 2004). However, the collaborative process used to develop such models is at least if not much more important than the models themselves (Schianetz et al. 2007; van den Belt 2004; Walker et al. 1999; Walters 1986).

Adaptive institutions must also be strong and credible (Seixas & Berkes 2003), with the presence of strong community-based institutions being particularly important (Nabhan 2001; Norton 2005). Institutions should be configured in a nested redundant configuration across organisational levels (local, state, national) to widen the scope of feedback they can access and respond to (Alcorn et al. 2003; Cash & Moser 2000; Gibson et al. 2000; Gunderson & Holling 2002; Low et al. 2003; Ostrom 1990; Ostrom et al. 2002; Tengo & Hammer 2003; Trosper 2003). Institutional redundancy (overlap) is important because it serves as an ‘insurance policy’ for the resource being managed, whereby institutions with similar functions can aggregate knowledge, serve as critical watchdogs of one another, or backfill should one institution weaken or make a catastrophic decision (Low et al. 2003). Institutions should also use simple rules (Baland & Platteau 1996) that are strongly and easily enforced (Baland & Platteau 1996; Ostrom 1990; Seixas & Berkes 2003; Wade 1988) using graduated sanctions (Baland & Platteau 1996; Ostrom 1990). Equity in resource access and rule enforcement is also important (Ostrom 1990; Seixas & Berkes 2003).

Finally, institutions also need to incorporate tight feedback loops from social-ecological systems to indicate the direction in which management should be proceeding (Carlsson 2003; Colding & Folke 1997; Levin 1999; Norgaard 1994; Seixas & Berkes 2003), and aggregate knowledge (including local and traditional) across diverse units via social learning and learning by doing within collective choice frameworks (Berkes & Folke 2002a, 1998; Blann et al. 2003; Gadgil et al. 2003; Gunderson et al. 1995; Kendrick 2003; Lee 1993; Low et al. 2003; Pahl-Wostl et al. 2007; Schianetz et al. 2007; Tengo & Hammer 2003). Collective choice arenas (such as the Ningaloo Tourism Futures project) should be used to ensure participation of multiple interests in identifying common preferred futures (Norton 2005) and to devise rules and policies (Baland & Platteau 1996; Carlsson 2003; Ostrom 1990; Schianetz et al. 2007; Wade 1988). Skilled and visionary leaders are also critical to successful cross-scale institutional collaboration (Olsson & Folke 2001; Ostrom 1990; Pinkerton 1999; Scott 1998). This also requires that institutions have conflict resolution capability (Low et al. 2003; Ostrom 1990). Using non-formalized and temporary multi-stakeholder institutions can help fill policy gaps and improve stakeholder relations in a way that leads to real institutional change (Gunderson 2003; Kendrick 2003). The use of ‘boundary organizations’ to mediate between scientists and decision-makers across different scales is also recommended (Cash & Moser 2000), as is the formation of partnerships that span across organisational boundaries (Laing et al.). In addition,
appropriate frameworks for evaluating the success of integrated and adaptive approaches to resource management are needed (Bellamy et al. 1999).

1.3.1.2 Barriers To Building Adaptive Institutions

Medema et al. (2008) examined evidence from a series of case study reviews looking at the implementation of adaptive management projects. The case studies examined by McLain & Lee (1996) showed that benefits from applying adaptive management were not always achieved. Walters (1997) cites that of the 25 major adaptive management planning exercises he has been involved in, 23 ‘vanished’ without visible product or became trapped in an endless cycle of model refinement. Medema et al. (2008) conclude that the barriers to institutional reform are considerable, and should not be underestimated. Bureaucracies seem unable to find novel solutions to confront uncertainty and resolve chronic resource problems (Gunderson 1999; Light et al. 1995; Pritchard & Sanderson 2002). Indeed, the literature is replete with examples of barriers to building adaptive capacity in institutions.

Since the 1970s, many writers have challenged the notion that managerial decision-making is rational or logical (Westley 2002). Rather, decisions are based on complex political pressures (Allison 1971) and contextual dynamics (March & Heath 1994), often using incomplete information (Westley 2002) and without the political will to implement necessary change (Gallopin 2002). For these reasons, command and control oriented centralized governments with political links to legislature and industry are prone to problems (Baskerville 1995; Holling & Meffe 1996) and susceptible to making large, sometimes catastrophic, mistakes (Gunderson et al. 1995). In addition, failure to accept the inherent social and ecological uncertainty pervading resource management issues, and the continued belief in the value neutrality of science and the rationality of decision-making, creates an adherence to largely ineffective serial approaches to policy making (Norton 2005). In serial policy making, information is gathered, models built, then policy developed. This process is void of any discussion of values of what is important and with unidirectional flow of information from scientists, to decision-makers and then to the public (Norton 2005). This separation of science and values increases miscommunication and prevents true learning, as the flow of important information between scientists, managers and other stakeholders is blocked (Norton 2005). Schianetz et al. (2007) further assert that management recommendations made by researchers will not be successfully implemented if they are not understood and accepted by managers and other decision-makers.

The creation of adaptive institutions is also challenged by institutional inertia caused by uncertainty, self-interest of individuals and organizations, greed and career concerns among scientists, as well as powerful vested interests that exploit and exaggerate uncertainty and gaps in scientific knowledge to maintain the status quo (Gunderson 2003; Gunderson et al. 2002; Pritchard & Sanderson 2002). Innovation induces resilience, but because it also undermines bureaucratic rule making and stability, innovators are put at risk when they undermine agency power structures and stability (Pritchard & Sanderson 2002). Inertia is further engendered by resistance from researchers and managers who fear failure, increased transparency, and political risks (Lee 1993; Walters 1997). As such, these individuals and organizations create ‘type II failures’ (failing to effect a desired event) by guarding against ‘type I failures’ (failing to stop an undesired event) (Bendor 1985). In addition, institutional inertia can be caused by the high cost of information gathering and monitoring (Lee 1993) and lack of capacity in terms of inadequate institutions, lack of financial resources, unskilled human resources, weak infrastructure, poverty, etc. (Gallopin 2002). Attempting to force all information into modelling tools (Norton 2005) and focusing on perfecting models rather than field testing them (Walters 1997), can also lead to inertia in decision-making. Indeed, Allison and Hobbs (2006) argue that paradigmatic policy changes are infrequent, occurring only during revolutionary upheaval, and when there are: 1) changes in ideas and understanding, and 2) changes in the key actors/interests. Otherwise, institutions select for favourable information and marginalise unfavourable information, regardless of its veracity (Bella 1996).

Insensitivity to environmental feedback also impedes the adaptive capacity of institutions. Larger, more centralised institutions are often more insensitive to negative environmental feedback than
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are local institutions (Alcorn et al. 2003; Holling & Meffe 1996), particularly where their dogma does not ‘fit’ with the feedback they are receiving (Colding et al. 2003). Global tightening of interdependencies between local resource users and regional, national, and international communities is further weakening feedback loops to the ecosystem (Folke et al. 2003; Folke et al. 1998). This is aggravated by support from socio-economic infrastructure (loans, subsidies, insurance, aid) at different scales, which impedes socio-ecological learning by making it possible to maintain business as usual during crises (Colding et al. 2003).

Problems with communication and participatory processes can also reduce adaptive capacity. It is difficult to reconcile the specialized understanding of researchers and management agencies with the place-based knowledge of communities (Pritchard & Sanderson 2002; Scott 1998). Scientists, managers and local people often believe their respective knowledge is superior, and have disdain for each others’ perspectives (Gadgil et al. 2003). Local knowledge often blends knowledge and belief without distinction, making it difficult for western science to accept (Gadgil et al. 2003). When managers and scientists act superior, local people get angry at what they perceive to be arbitrary scientific judgements; consequently, communication breakdown and loss of trust occurs (Kendrick 2003; Westley 2002). Loss of trust can lead to erosion of social resilience (Tendo & Hammer 2003). The polarization that arises between stakeholders may itself inhibit development of ability to respond to ecosystem signals (Troper 2003) as competing interests, each with virtual veto power, stifle innovation (Pritchard & Sanderson 2002). Face-to-face communication in participatory processes can also create preference falsification through intimidation or manipulation (Pritchard & Sanderson 2002), and horizontal power relations within local communities almost always reinforce existing inequalities and the status quo inside such communities (Buhler 2002; Kapoor 2002; Mohan 1999; Mohan & Stokke 2000; Reed 1997). In addition, when people or a society have not dwelled in an ecosystem for long periods of time, their understanding of underlying processes and functions is slow to develop (e.g. Muchagata & Brown 2003). As such, even the simplest multi-equilibrium models used in decision-making processes can “confuse rather than inform the public” (Pritchard & Sanderson 2002, p.206). Finally, adaptive capacity can also be jeopardized by rapid technological or socio-economic change (Seixas & Berkes 2003), and blanket, high cost regulations that are viewed as unfair or are difficult to enforce (Ostrom 1990).

1.3.1.3 Knowledge and Adaptive Capacity

Knowledge plays a pivotal role in increasing the adaptive capacity of a system and it institutions. The need for knowledge integration and sharing between a diversity of disciplines and stakeholders has been widely acknowledged in the literature (Balmford & Cowling 2006; Braunisch et al. 2012; Folke et al. 2005; Lynam et al. 2007). Campbell and Schofield (2007) identify knowledge, together with commitment and capacity, as one of the three pillars of sustainable natural resource management. Meppem and Gill (1998) similarly contend that sustainable development should be geared more toward learning than future outcomes. Folke et al. (2005) argue that adaptive governance requires that actor groups in a system draw on various knowledge systems. In particular, they note that knowledge and understanding of resource and ecosystem dynamics are required, such that governance systems can detect and respond to environmental feedback. Likewise, Roux et al. (2006) state that sustainable ecosystem management relies on a broad-base of knowledge that is continuously updated to reflect current issues and needs, and which flows from scientists to managers with minimal delay:

Today, more than ever, we recognize that sustainable ecosystem management depends strongly on the acquisition and use of integrated systems of knowledge that continuously replace outmoded techniques as our understanding evolves. Unobstructed knowledge flow between science (often considered the arena of the “experts”) and management (similarly seen as the domain of “decision makers”) is particularly important in times of significant change, such as policy reform and implementation.

Scientists are now under considerable societal pressure to share their knowledge and see that research is used (Lovejoy 2009) and many researchers working on environmental issues have called for stronger linkages between science and policy (Brown 2003; Lomas 2000; Mitchell & Lankao
2004; National Research Council 1999; Stone et al. 2001). In Australia, there are several hundred publicly funded organisations involved in the generation and management of formal scientific knowledge in natural resource management. The primary intended clients of this system are several hundred government agencies, as well as thousands of private sector and community groups (Campbell & Schofield 2007). These groups are illustrated in Figure 1.2.

Figure 1.2. Key components of the Australian natural resource management system (source: Campbell 2007).

1.3.2 Knowledge Transfer Challenges

Roux et al. (2006) describe knowledge transfer as the “broad banner used to describe strategies for attempting to bridge the knowledge divide between research, policy and management operations”. Yet despite mounting effort and imperative to bridge the gap between research and management, knowledge transfer efforts “often fall short of creating alignment and seamless flow of knowledge between groups” (Roux et al. 2006). Roux et al. (2006) attribute this to a legacy of disciplinary fragmentation that has divorced scientific knowledge from its application, to the detriment of natural resource management. From an environmental policy perspective, McNie (2007) states that decision-makers often lack information to make good decisions, and that globally policy makers are calling for more ‘useful’ information for decision-making. This phenomenon has also been widely
observed in the field of ecological management (Boreux et al. 2009; Born et al. 2009; du Toit et al. 2004; Knight et al. 2008). Laszlo and Laszlo (2002a) argue that bridging the research-management gap in ways that foster lifelong learning and knowledge operationalization among people, institutions and communities represents one of the greatest challenges to global sustainability. Research-implementation gaps in other sectors such as public health have been successfully narrowed (Boreux et al. 2009), perhaps because the cost of failure in these sectors is high (van Kerkhoff & Lebel 2006) and immediate, suggesting the task, however difficult, is not insurmountable in the environmental sciences.

So why is it that efforts to improve research uptake by management so often fall short, despite growing recognition that sustainable environmental management requires the ongoing integration of new and relevant knowledge? McNie (2007, p.25) states that: “we have little understanding of ‘knowledge and decision systems’ and lack a framework for understanding, researching and improving upon decision processes, particularly with regard to environmental decision-making.” This lack of understanding has in part been attributed to the failure of those in the natural sciences to appreciate the contributions of the social and behavioural sciences (National Research Council 1999). This is a considerable oversight, given that most of the barriers to improving the adaptive capacity of institutions are related to social processes operating both within and outside of these human systems. These barriers can also be understood in relation to recent work linking complexity theory with the behaviour of human organizations.

1.3.3 Potential Contributions from the Social and Complexity Sciences

For decades, issues around cognition, organizational learning and the effective sharing and application of knowledge have occupied social science scholars (Argyris & Schön 1974, 1978; Bartunek & Moch 1987; Brown & Duguid 1991; Festinger 1957; Forrester 1968, 1971; March 1991; Maturana & Varela 1992; Meadows et al. 1972; Nonaka & Konno 1998; Nyhan & Reifler 2010; Nystrom & Starbuck 1984; Senge 1990; Snowden 2003; Wenger 1998). Since the 1950s, the systems dynamics field has been used to understand the behaviour of complex, dynamic systems, including the behaviour of socio-environmental systems (Forrester 1968, 1971; Meadows et al. 1972) and organisations (Senge 1990). More recently, organisational management scholars have been looking to complexity theory (Holland 1995; Kauffman 1995; Langton 1986) to help explain how human organizations learn and function, and to find ways of making these organizations more adaptive (Shaw 2002; Stacey 1996b, 2001). Complexity theory is now also being applied by knowledge management scholars as a means of better understanding how knowledge is generated, shared and applied in organisations (Kakihara & Sorensen 2002; McElroy 2000; Snowden 2003).

According to Easterby-Smith et al. (2008) knowledge transfer is a complex phenomenon that is rarely successful in practice. They note that this is the case even between units within organisations. Environmental scientists, however, have traditionally held a relatively simplistic view of knowledge transfer as a mechanical process of transferring research findings from scientists to managers and management institutions. The focus of such knowledge transfer efforts has largely been on improving:

1. salience, credibility and legitimacy of research and modelling results;
2. interpretation of research/modelling results into information that is relevant and compelling to target audiences/users;
3. distribution of generated information/models to the ‘right’ audiences/users;
4. institutionalisation of information/models in organisational memory and structures (i.e. policy and procedures).

This approach, which Huber (1991) describes as a behaviourist approach to learning, is premised on the assumption that if an entity receives and processes information, its behaviour will change. However, the simplicity of this assumption has long been disputed by those who apply cognitive approaches to learning. Learning and behaviour change are the result of complex cognitive and social processes; rarely does the presentation of new information on its own, regardless of how
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compelling, cause substantial changes in individual or organizational behaviours (Argyris & Schönb 1974, 1978; Bartunek & Moch 1987; Markus & Zajone 1985; Weakland et al. 1982). Indeed, research on cognitive dissonance has shown that presenting people with new information can actually cause them to entrench their existing behaviours and more strongly resist further change (Nyhan & Reifler 2010). Likewise, learning that does not result in major shifts in a learner’s beliefs and underlying assumptions typically fails to change their behaviour in substantial ways, indeed often escalates errors being committed (Watzlawick, 2011).

In addition, knowledge management scholars draw an important distinction between information and knowledge, one which is again largely unrecognised by those in the environmental sciences. Knowledge contains an unspoken tacit component that is linked to people’s relationships and capacity to act (Nonaka & Takeuchi 1995), whereas information, or explicit knowledge, seldom results in behaviour change on its own. The social sciences also present a large body of work describing preconditions for learning and behaviour change, which is largely unrecognized by those in the environmental sciences. Very generally, for example, it has been shown that learning and behaviour change can be enhanced by free and open dialogue, trust and relationships, repeated interpersonal interaction, surfacing conflicting viewpoints, participation, sharing control and responsibility, minimising defensiveness, crisis and destabilisation and deep reflection (Argyris & Schon 1996; Bartunek & Moch 1987; Chapman 2004; Hedberg et al. 1976; Wenger 1998). Deploying a knowledge broker (Lomas 2007) or change agent (Bartunek & Moch 1987) can also help catalyse the social interactions needed for organisational learning to occur. McNic (2007) points out that knowledge brokers appear to play an important role in spanning the divide between scientists and policy makers, but notes that little is known about them or what they do, and that more research is needed in this area.

The difficulty of changing organisational behaviours can also be viewed through the lens of complexity theory and by viewing organisations as complex adaptive systems subject to emergent order (Stacey 1996a). Emergent order consists of large scale patterns of behaviour that spontaneously and unpredictably arise from small scale interactions of an organisation’s members (Seel 2006; Stacey 1996a). Once formed, emergent order typically resists change; attempting to change such systems using centralized control or structure will have limited effectiveness because the systems are dynamic and unpredictable (Seel 2006). However, by increasing the connectivity, diversity and rates of information flow between their members and/or outside groups, organisations can spontaneously become more responsive and adaptive to their environments (Seel 2006; Stacey 1996a). As such, conversation can be viewed as the currency of change in organisations (Shaw 2002).

Knowledge transfer is also challenging because of the complex nature of human social systems. Complexities and difficulties multiply when attempting to transfer knowledge between organisations because of the “multifaceted nature of the boundaries, cultures, and processes involved” (Easterby-Smith et al. 2008,p.677). This makes it impossible to devise a standard recipe for engaging stakeholders in a knowledge transfer process. The composition, influence, knowledge, motivations and actions of stakeholders differ for any given place and for any given time, with groups and people forming complex and ever-changing webs of relationships that are inherently unpredictable. This capacity of human systems to spontaneously change in unpredictable ways places limits on our ability to design and plan a knowledge transfer process. In addition, the researchers themselves affect the social system – as soon as they begin interacting with stakeholders, stakeholder perceptions, knowledge and actions begin to change in response (Capra 1997; Heisenberg 1930; Juarrero 1999).

Clearly the social and complexity sciences have much to contribute to our understanding of knowledge transfer in environmental management. The importance of using knowledge and feedback to improve adaptive capacity is not reserved for resource management agencies; to be competitive and successful, businesses must also be able to continuously learn and quickly transform their learning into action (Senge 1990; Senge et al. 1999), i.e. they must be adaptive. Easterby-Smith et al. (2008) state that 20 years of empirical research has shown that knowledge transfer within and between firms can improve their learning capacity and create competitive
advantage. Many businesses aim to improve their learning and adaptive capabilities by undertaking strategic or change management initiatives. Senge (1990) refers to such businesses as ‘Learning Organizations’. Change management in the business world is widely premised on understandings and theories of organisational behaviour derived from the fields of organisational learning, knowledge management and complexity theory.

However, as is the case with adaptive management projects in the environmental management world, Senge et al. (1999) note that most business-related change management initiatives fail, citing studies showing failure rates of around 70%, while Burnes (2005) cites rates of 80% and higher. Burnes (2005) observes that despite increasing imperative for increasing the adaptive capacity of organisations, given unprecedented levels of change they now face, there remains significant difficulty in successfully bringing it about, despite decades of debate in the management literature around how to manage change.

This suggests the problems associated with achieving successful knowledge transfer and improved adaptive capacity run deeper than a simple failure to integrate disciplinary learnings across silos. Indeed, the failures rates common to both the social and environmental sciences, despite their very different approaches, suggest a common root to the problem, one not yet adequately addressed in either arena.

1.3.4 Problem Formulation & Underlying Assumptions

“The problems we have created in the world today will not be solved by the level of thinking that created them.”

—Albert Einstein (1946)

This 1946 quote by Albert Einstein is a reflection of Godel’s Incompleteness Theorem⁵, whereby Godel mathematically proved that:

No system can prove its consistency within its own framework, proof can only come from outside, with additional axioms, premises, concepts, comparison’s etc., which the system cannot prove, and which themselves are only provable by recourse to yet a wider framework. (cited in: Watzlawick et al. 2011, p.24)

Godel’s theorem established the essential limitations of axioms in arithmetic systems, by showing that within such systems there is always a statement, which although apparently true, cannot be proven within the system⁴. In other words, the theorem shows that there are problems which cannot be solved using the rules and premises that govern the system within which the problems are situated. Such problems can only be solved by adding new premises or ‘rules’, i.e. new starting points for reasoning. Meppem and Bourke (1999) interpret Einstein’s observation⁵ as indicating that the sustainability problems we have created are a result of certain dominant ways of thinking and knowing in Western society, which cannot therefore be used to successfully resolve such problems.

In 1974 Watzlawick et al. published their seminal work Change: Principles of Problem Formulation and Problem Resolution (Watzlawick et al. 2011). The book applies theorems from mathematical logic

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³ See Appendix 2 for an explanation of the theorem.
⁴ Meaning a set of axioms or rules can never fully explain the system it is meant to account for. For example, any statements that assert their own falseness are not provable within their own framework, such as the all Cretans are liars’ paradox, which can only be proven if the Cretan who speaks the statement is not classed as a Cretan.
⁵ Franzen (2005) notes that Godel’s theorems have been widely invoked—often erroneously—in realms outside of math and logic, in fields ranging from theology and literature to physics and postmodernism. These invocations are often inappropriate, given the theorems only apply to formal theories of mathematical logic (specifically, consistent axiomatic systems capable of arithmetic). In this thesis, where I relate Godel’s theorems to non-formal systems, it is as a metaphorical extrapolation of Godel’s notion “that the real behavior (truth) of nature is larger than any purely predicative, syntactic, model of it” (Maier 2006, p.126). Where I relate Godel to complexity, however, note that Godel’s theorem is legitimately: 1) a means of mathematically explaining emergence in complex systems e.g. (Baas & Emmeche 1997), and 2) a source of (logical) complexity in unpredictable human systems (Biggiero 2001). Also, Chaitin’s information theory “suggests that the incompleteness phenomenon discovered by Godel is natural and widespread rather than pathological and unusual” (Chaitin 1982, p.941), indicating the premise behind Godel’s theorems is more than just an isolated paradox.
(including Godel’s) to explain why problems arise and why they are perpetuated in some instances and resolved relatively easily in others (see Appendix 2 and Appendix 4, Section A4.4.3 for detailed explanations). Likewise, Conklin argues that complexity is not necessarily the defining character of wicked problems, rather “it is about a fundamentally different kind of challenge…one that makes solution secondary and problem understanding central” (Conklin et al. 2007). Watzlawick et al. (2011) outline how seemingly intractable problems (e.g. wicked problems) that appear to defy resolution are unintentionally reinforced (and sometimes even created) by the very strategies applied to try and resolve them. As per Einstein’s observation and Godel’s theorem, the solutions that can actually resolve such problems are inevitably qualitatively very different than those previously attempted because they necessarily stand outside the modes of thought that created the problem to begin with. As such, wicked problems call for a qualitatively different approach to conventional problem solving (Palmer et al. 2007), as no level of linear thinking can ever formulate their solution (Conklin et al. 2007). Watzlawick et al. (2011) suggest that finding such solutions requires standing back from the problem, looking for the deep assumptions and thought patterns that underpin their attempted solutions, then reframing the problems accordingly.

Thus, in keeping with Watzlawick et al.’s (2011) principles of problem formulation, we first need to step back and recognize some of the core assumptions underpinning Western society’s understanding of reality and knowledge. This is needed to transcend the dominant modes of thought which lock us into patterns of behaviour and problem-solving that unintentionally perpetuate or escalate the problems we are trying to resolve, such as ineffective knowledge transfer in the case of this study. These assumptions, which we unconsciously absorb and pass on, are so deeply rooted in the Western psyche that most people who are unfamiliar with metaphysics and epistemology (i.e. most people) are completely unaware that their perception of the world is largely shaped by these overarching assumptions (Bateson 2002; Shotter 1994) or indeed, that there are alternate ways of conceiving reality and knowledge other than that dictated by the traditional science-based paradigm that has prevailed in the West since the Victorian era (see Capra 2010). The famed psychologist and anthropologist Gregory Bateson writes:

> I have taught various branches of behavioural biology and cultural anthropology to American students ranging from college freshmen to psychiatric residents, in various schools and teaching hospitals, and I have encountered a very strange gap in their thinking that springs from a lack of certain tools of thought. This lack rather equally distributed at all levels of education, among students of both sexes and among humanists as well as scientists. Specifically, it is a lack of knowledge about the presuppositions not only of science but of every day life. (Bateson 2002, p.23)

A basic function of philosophy is to examine the assumptions that underlie our thinking (Heylighen et al. 2007). Lyotard (1984) states that whereas an expert knows what he does and does not know and concludes, a philosopher knows neither, and instead questions. However, today’s natural scientists—being experts—are largely unschooled in philosophy and its role in shaping history, science and our understanding of the world. This ‘divorce’ between science and philosophy is relatively recent, having occurred sometime after WWII (Rovelli 2012). Quantum physicist Carlo Rovelli (2012) notes that it is fashionable today to discard philosophy, to believe that it is unnecessary because we have science. He argues that this is a naïve attitude, that our greatest scientists—Heisenberg, Einstein and Galileo, for example—made such momentous discoveries because they were fully versed in philosophy. Rovelli, among others, is now making strong arguments that science, far from having freed itself from philosophy, is in dire need of its help (Bohm 2012; Noë & Thompson 2004; Peat 1990; Rovelli 2012).

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6 Chalmers (2002) observes that although scientists are good at scientific progress, they are not “particularly adept at taking a step back from their work and describing or characterising the nature of that work” (p.252).

7 Rovelli (2012) suggests the divorce between science and philosophy worked for the last half of the 20th century because the scientists operating in the ’50s were very, very smart, and most of our present day science is founded on their ideas. However, physics is at a point now where a return to philosophy is needed.
Chapter 1

The ‘allergy’ scientists have acquired for philosophy is poignantly illuminated in this quote by John Maddox, senior editor for Nature, in his attack on Rupert Sheldrake’s (1981) controversial theory of morphogenesis:

Sheldrake’s is not a scientific theory. Sheldrake is putting forward magic instead of science, and that can be condemned, in exactly the language that the Pope used to condemn Galileo, and for the same reasons: it is heresy. (Maddox 1994)

Maddox’s reference to Galileo drips with irony, as did the headline for his (Maddox 1981) editorial in Nature. A book for burning? wherein he states that Sheldrake’s book “is the best candidate for burning there has been for many years”. Indeed, the antagonism generated by Sheldrake’s theory runs so deep that 20 years later, Freeman (2005) claims journals still run the risk of ostracism if they publish Sheldrake’s work. Freeman (2005) attributes the scientific establishment’s hysterical and dogmatic attacks on Sheldrake’s work to a divisive moralism (the heretical ‘anti-science people’ vs. the ‘good’ pro-science people), and a commitment to the existing scientific paradigm that is so strong that explorations of alternatives outside of it are rejected. Indeed the reaction to Sheldrake’s theory is as predicted of ‘normal’ scientists in Kuhn’s (1962) paradigmatic theory of scientific progress. According to Kuhn, normal scientists assume “that a paradigm provides the means for the solution of the puzzles posed within it”, and are therefore uncritical of it (Chalmers 2002, p.110). As such, observations or theories that fail to fit the dominant paradigm are often discredited or dismissed as anomalies by the normal scientific community (Kuhn 1962).

One of the less daunting barriers to natural scientists familiarising themselves with philosophy is the language and terminology used in texts on the subject. These may appear to be impenetrable to those without formal training in the field. Watzlawick et al. (2011) note that helping people reframe their problems requires translating potential solutions into their own language and presenting them in ways consistent with their conceptualizing of reality, i.e. their paradigm.

1.4 Conceptual Framework

Most qualitative research is seen as being free from predetermined theories and questions (Jacob 1988), which generally emerge after data collection, as opposed to before. However, Eisenhardt (1989) notes that “a priori specification of constructs can also help shape the design of theory-building research,” because it permits more accurate measurement of constructs during the research.

The concept of resilience—which assumes that that the ability of socio-ecological systems to weather disturbances is partly a function of their ability to learn and adapt—was the fundamental underlying framework for this study. As such, the core assumption at the study outset was that the adaptive capacity of institutions responsible for governing natural resources is reliant on their ability to respond to feedback from the socio-ecological system they are attempting to manage, and that knowledge transfer is a mechanism for enhancing such feedback.

In the literature it is commonly noted that knowledge transfer is more likely to result in practice change when relationships are established between researchers and research recipients. Park (1999) has devised a typology of types of knowledge that are generated during participatory research projects: representational, relational and reflective. Each of these effect higher orders of behavioural change. Representational knowledge is that which depicts or explains reality, such that we are better able to predict and control it; it typically consists of facts and figures, and is that which is sought and privileged by the natural sciences. Relational knowledge is created when one comes to know and develop a relationship with another human being. It is the foundation of social capital and facilitates the sharing of representational knowledge and social change. Reflective knowledge is

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8 Sheldrake (1981) applies the metaphysical thinking of philosopher and mathematician Alfred Whitehead in generating an alternative explanation to account for the holist nature of organisms. His work had received a mildly positive reception in New Scientist and among some quantum physicists before the furore raised by Maddox’s attack in Nature. The attack effectively ended Sheldrake’s academic career as a respected and up-and-coming plant physiologist (Freeman 2005).

9 For this same reason, I was hesitant to risk making any reference to Sheldrake in this thesis.
that which results from rational and moral deliberation, and is what commits people to interact and act. These notions are central features of the conceptual framework that I developed for the action research study component of this investigation. This framework is outlined in Chapter 3.

Godel’s Incompleteness Theorem and Watzlawick et al.’s (2011) principles of problem formulation indicate that seemingly intractable, or ‘wicked’, problems cannot be solved using the rules and assumptions that govern the system within which the problems are situated—such problems can only be solved by surfacing and discarding old assumptions and establishing new starting points for reasoning. This principle guided the theoretical component of this study and led to a reformulation of the problem of research uptake and a reconceptualization of the notions of knowledge transfer and adaptive capacity.

1.5 Organisation of the Study

This thesis consists of seven chapters organised into three parts. Part I starts with this introduction outlining the study significance and purpose. This is followed by a brief literature that serves as the study rationale, and an introduction to the study’s conceptual framework and core assumptions. Next is an outline of the project methodology. Part II presents a detailed conceptual framework that informed the action research component of the study. This is followed by a detailed chronology of the action research study, which is analysed against the conceptual framework. Part III presents the theoretical investigation component of the study. This starts with a theoretical exploration that surfaces and revises the underlying philosophical assumptions that underpinned the study at its outset. It is followed by an application of the revised assumptions to key concepts that inform the study. In the final chapter insights from these explorations are used to reframe the study problem and the results of the action research study. It concludes by relating the study’s implications for environmental management.

Part I: Introduction & Approach

Chapter 1 - Introduction

In Chapter 1, I introduce the situation that created the impetus for this study, and the study’s significance and purpose. I then outline the purpose of this study: to pair a multidisciplinary theoretical investigation with action research to shed light on why knowledge transfer efforts so often fall short, and in doing so, devise a new conceptual framework for understanding and applying knowledge transfer in the environmental management field. I then outline the fields of knowledge that rationalised and informed this study at its outset. I also present an overview of the potential contributions the social and complexity sciences can make in terms of understanding and enhancing knowledge transfer. This is followed by an argument for how philosophy can help uncover cultural assumptions that lead to errors in problem formulation, and in so doing inadvertently perpetuate or escalate the wicked problems we are trying to solve. In concluding, I introduce the conceptual framework and core assumptions that informed the study at its outset, and provide an outline of the study organisation.

Chapter 2 - Methodology

In Chapter 2, I outline and justify the project methodology. I begin by revealing my research paradigm as being both positivist and interpretivist, and outlining the principles of a qualitative action research approach. I then justify my selection of action research as an approach, and my selection of case study and phenomenological analysis. I also describe the methods I used to collect data, including in-depth interviews, participant observation and key informants. I then outline the study design as a single plan-act-reflect action research cycle, companioned with an in-depth multidisciplinary theoretical investigation.
Chapter 1

Part II: Thesis—testing a conceptual framework for building adaptive capacity

Chapter 3 – Conceptual Framework

In this chapter, I develop the conceptual framework for the action research component of the study by reviewing some recent environmental management perspectives on knowledge transfer. First, I summarise the knowledge transfer barriers highlighted in key literature reviews. I then provide an overview of literature reviews illustrating the shift towards participation as a means of better integrating science with management and producing useful information, thereby improving the likelihood of research application. I also outline the three types of knowledge produced during participatory research: representative, relational and reflective. I then detail selected collaborative knowledge transfer approaches, including social learning, extension, and research for development. In concluding, I outline the role the boundary organisations and knowledge brokers can play in bridging the gap between science and management.

Chapter 4 – Action Research Chronology

In Chapter 4, I chronicle the outcomes of the action research component of this study, and analyse them against the conceptual framework in Chapter 3. I start by presenting the study background, including an overview of the Ningaloo research program and its associated modelling projects. This is followed by a summary of how the project began by embedding myself in the Ningaloo community for 18 months as a knowledge broker between NRP modelling researchers and local stakeholders. I describe the planning stage of the action research cycle, where I conducted 30 in-depth interviews with scientists and local stakeholders to determine their perspectives on knowledge transfer barriers and opportunities in the region, and analyse these results against the conceptual framework in Chapter 3. I then describe the action stage of the action research cycle. This involved using the knowledge and relationships cultivated during the interviews to help catalyse new connections in the Ningaloo system by match-making researchers with managers. It also involved opportunistically entering into knowledge transfer collaborations with both researchers and local stakeholder groups. For the reflection stage of the study, I summarise reports I co-authored with the modelling researchers, which reflect on the outcomes of our knowledge transfer and stakeholder engagement activities. I also present the results of my final round of evaluation interviews, which looked at how the scientists and local stakeholders had been affected by the knowledge transfer process, and the types of knowledge generated. I then analyse these results against the conceptual framework presented in Chapter 3.

Part III: Synthesis—a new framework for building creative capacity

Chapter 5 – Surfacing and Revising Assumptions

The principles of problem formulation specify that the first step in resolving seemingly intractable problems, such as that of knowledge transfer, requires examining the assumptions that underpin our thinking about the problem situation. This is the function of philosophy. To this end, I compiled a plain language review of relevant topics in the history of Western science, philosophy and mathematics, the shifting nature of their underpinning assumptions, and how they have entwined and mutually shaped each other since ancient times (see Appendix 1). The second step involves opening our minds to alternative ways of thinking and revising our assumptions accordingly. To this this end, I also compiled reviews of relevant concepts in mathematical logic (see Appendix 2) and the complexity sciences (see Appendix 3). In Chapter 5, I synthesise these reviews. First I synthesise the literature that identifies and challenges the underlying assumptions and philosophies of the Newtonian paradigm that currently dominates Western thinking and which informed this study’s approach at its outset. I then propose an alternative complexity-based ontology that unifies the metaphysics of materialism and idealism, based on a synthesis of the Whitehead’s process philosophy, mathematical logic, quantum theory, general systems theory and the complexity sciences.
Chapter 1

Chapter 6 – Through the Complexity Lens:

In Chapter 1, I indicated the potential contributions the social sciences can make in terms of understanding and enhancing knowledge transfer. To that end, I compiled a review of relevant social science topics (see Appendix 4). In Chapter 6, I draw on this review to discuss the phenomena of cognition, learning, knowledge and organising in relation to how they’ve been understood within the Newtonian paradigm, and how they are now being explained from the perspective of a complexity-based paradigm. While both the Newtonian and complexity paradigms have predictive power when describing these phenomena, the complexity-based paradigm is shown to resolve some of the learning paradoxes created by Newtonian assumptions. It is also shown to have profound implications for how we understand learning, knowledge, organisations and other social phenomena.

Chapter 7 – Implications for Science & Environmental Management

I begin Chapter 7 by outlining the limits of reductionist science as understood through a complexity-based paradigm. I then proceed to illustrate how Newtonian assumptions that inform our understanding of knowledge transfer and adaptive capacity amount to errors in problem formulation. I then show how these errors generate paradoxical situations that inadvertently perpetuate or escalate the environmental problems we are trying to solve. Based on this discussion I reframe this study and re-examine the action research results from a complexity perspective. In the final discussion, I posit that the research uptake problem should be reformulated from the basis of complexity paradigm, and the notions of knowledge transfer and adaptive capacity be reconceptualised. I conclude the chapter by proposing a number of possible strategies for addressing the reformulated problem of research uptake, and identify further research needs.
Chapter 2
METHODOLOGY

“In order to penetrate ever further into their subjects, the host of specialists narrow their field and dig down deeper and deeper till they can’t see each other from hole to hole. But the treasures their toil brings to light they place on the ground above. A different kind of specialist should be sitting there, the only one still missing. He would not go down any hole but would stay on top and piece all the different facts together."
—Thor Heyerdahl (1976)

2.1 Introduction

As with most action research projects, this study began with considerable fuzziness about questions and method (Herr & Anderson 2005). Action research methodologies typically evolve as the researcher pursues plan-act-reflect cycles, and the literature develops as the researcher’s understanding of the issues under study deepen (Herr & Anderson 2005). The ‘action’ component of this study involved embedding myself for 18 months (from July 2009 to December 2010) in the Ningaloo region. I adopted the role of a knowledge broker and began actively engaging stakeholders and collaborating with researchers in devising a loose and tentative knowledge transfer framework. This framework then evolved with input and direction from participating stakeholders, and as I delved deeper into the literature to better understand emerging phenomena. The methods used to engage stakeholders and reflect on the study results also evolved as the project progressed. The purpose of this chapter is to provide a rationale for the study methodology and a retrospective outline of the data collection methods and study design used.

2.2 Rationale

2.2.1 Paradigm

In conducting and writing about this study, I worked from both a positivist and an interpretivist paradigm. In the positivist paradigm it is assumed that there is an external objective reality that can be described, studied and understood. Positivist studies generally attempt to test theory with the aim of increasing the predictive understanding of phenomena. In this case, I tested to see whether a knowledge broker could help catalyse relationships during a knowledge transfer process, and improve specific knowledge transfer outcomes as a result.

However, I also applied an interpretivist paradigm, which assumes that there are many subjective realities. As such, interpretivists aim to understand phenomena through the meanings that others assign to them. They describe how phenomena are experienced by the people involved. Interpretive studies do not predefine dependent and independent variables, but focus instead on the complexity of human meanings as situations emerge (Kaplan & Maxwell 1994). In this case, I described the phenomena that emerged from knowledge transfer activities from the perspectives of participants involved in the knowledge transfer process.

2.2.2 Approach

2.2.2.1 Qualitative Action Research

The approach applied in this study is qualitative action research. Qualitative research methods seek to “describe, decode, translate and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world” (van Maanen 1983, p.9). Qualitative approaches are appropriate when the goal of research is to understand a phenomenon from the point of view of the participants and its particular social and institutional context, as this information is largely lost when textual data are quantified (Kaplan & Maxwell 1994). Types of qualitative data include interviews, documents, and participant observation data.
Action research is a qualitative research approach that has the dual aims of action and research: action to bring about change in some community, organization or program, and research to increase understanding on the part of the researcher and/or client (Dick 1993). According to McKernan (1988, cited in Herr & Anderson 2005, p.4), action research is “a form of self-reflective problem solving, which enables practitioners to better understand and solve pressing problems in social settings”. According to Herr and Anderson (2005), action research is best conducted in collaboration with others who have a stake in the problem being investigated. It thus tends to be participatory. Action research also demands some form of intervention, unlike traditional social science research that aims for objective neutrality (Herr & Anderson 2005). The intervention has four major phases: plan, act, observe and reflect (Zuber-Skerritt 1991). It pursues a cyclic path to allow for a least one stage of critical reflection on the outcomes and the process (Allen 2001). The stage of critical reflection searches for both confirming and disconfirming evidence.

Thus action research provides a framework for formalising the natural process of learning by building on experience. Action research emphasises possibility and learning10 (Susman & Evered 1978), whereas positivist science aims for prediction through induction and deduction. It is a research perspective that is uniquely intended for discovering, understanding, and fostering innovations in social-organisational arrangements and processes (Cooperrider & Srivastva 1987). In other words it is generative. Action research is intended to benefit the community or organisation under study. Thus the knowledge and understanding it generates are made accessible to those being studied as well as to the scientific/research community.

Because action research is both flexible and reflexive it is useful for investigating problems in complex social systems. Quantitative science has limited ability to describe such systems because they have ‘soft’ boundaries and multiple indiscrete variables. Swepson effectively summarises this difference between scientific method and action research:

Scientific method makes the value choice to pursue generalisable knowledge rather than situation specific knowledge, i.e. to pursue external validity at the expense, if necessary, of internal validity. Therefore, it chooses problems where it is possible to extract meaningful relationships between discrete variables...

...Action research makes the value choice of pursuing situation specific knowledge rather than generalisable knowledge, i.e. it will trade off external validity for internal validity, if necessary. Therefore, it is generally applied to complex, social situations which are a complex set of relationships between indiscrete variables and it is not possible to choose which variables are crucial. (Swepson 1995)

Another feature of action research is that, unlike quantitative studies, action researchers do not strive to be objective, value-neutral observers, separated from the community under observation by their ‘expert’ status (Sisman & Evered 1978). In action research studies, the relationship between the researcher and the community (i.e. stakeholders) is critical, with the researcher taking on an interventionist role as an active, invested participant working to change how people perceive and operate in their worlds (Cooperrider & Srivastva 1987). Action researchers typically choose to solve problems that contribute to general knowledge while also bringing about positive social change (e.g. healthy communities, environmentally sound management, etc.) (Allen 2001).

Herr and Anderson (2005) also note that when conducting action research the literature is ‘in dialogue’ with the data. Thus, as the research progresses and the investigator’s understanding of the issues under study deepen, the literature drawn on by the study will develop and increase. Hence, both data analysis and literature review should be ongoing. The outcome is that “the data analysis is pushed by relevant literature and the literature should be extended through the contribution of this action research” (Herr & Anderson 2005, p.84). Herr and Anderson (2005)

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10 Contemporary positivist science has, however, moved forward in recent decades, as indicated by initiatives such as the Millennium Project (see: www.millenniumassessment.org). This project synthesises scientific information with knowledge held by the private sector, practitioners, local communities and indigenous peoples to predict the effects of ecological change on human well-being, and to assist policy-makers in global, regional and local decision-making.
Further note that “there is a sense of unearthing the real issue or questions for study, and this often leads researchers to read in directions they had not previously anticipated” (p.84). Table 2.1 compares positivist (mainstream) science and action research.

**Table 2.1.** Comparisons of positivist (mainstream) science and action research (adapted from Susman & Evered 1978).

<table>
<thead>
<tr>
<th>Points of comparison</th>
<th>Positivist science</th>
<th>Action research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value position</td>
<td>Methods are value neutral</td>
<td>Methods develop social systems and release human potential</td>
</tr>
<tr>
<td>Time perspective</td>
<td>Observation of the present</td>
<td>Observation of the present plus interpretation of the present from knowledge of the past, conceptualisation of more desirable futures</td>
</tr>
<tr>
<td>Relationship with units</td>
<td>Detached spectator, client system members are objects to study</td>
<td>Client system members are self-reflective subjects with whom to collaborate</td>
</tr>
<tr>
<td>Treatment of units studied</td>
<td>Cases are of interest only as representatives of populations</td>
<td>Cases can be sufficient sources of knowledge</td>
</tr>
<tr>
<td>Language for describing units</td>
<td>Denotative, observational</td>
<td>Connotative, metaphorical</td>
</tr>
<tr>
<td>Basis for assuming existence of units</td>
<td>Exist independently of humans</td>
<td>Human artefacts for human purposes</td>
</tr>
<tr>
<td>Epistemological aims</td>
<td>Induction and deduction</td>
<td>Conjecturing, creating settings for learning and modelling of behaviour</td>
</tr>
<tr>
<td>Criteria for confirmation</td>
<td>Logical consistency, prediction and control</td>
<td>Evaluating whether actions produce intended consequences</td>
</tr>
<tr>
<td>Basis for generalization</td>
<td>Broad, universal and free of context</td>
<td>Narrow situational and bound by context</td>
</tr>
</tbody>
</table>

Although there was long debate over whether or not action research is a science (e.g. Argyris 1983; Checkland 1981; Susman & Evered 1978), the action research paradigm has been accepted as a valid research method in applied fields such as organisational development and education. It also has growing application in the fields of community development, environmental management, and information systems. According to Allen (2001), the rising use of action research in environmental management recognises that natural resource management issues are not "characterised so much by problems for which an answer must be found but rather by issues which need to be resolved and will inevitably require one or more of the parties to change their views.” The underlying assumption of these approaches is that effective social change depends on the commitment and understanding of those involved in the change process (Allen 2001).

2.2.2.2 *Action Research for this Study*

The primary aim of the field component of this study was to describe the nature and effects of knowledge transfer between NRP researchers and stakeholders in the Ningaloo region, with special attention to the role of knowledge brokering. I selected action research as the approach for this study for a number of reasons. Firstly, its flexibility lends itself to achieving action in work or community situations. In this case, I used action research as means of bringing researchers, bureaucrats and other stakeholders together to take part in a knowledge transfer process in the Ningaloo region. Flexibility was required because these actors were already engaging with each other and the process of bringing their work together would evolve rapidly.

Secondly, qualitative action research is a participatory approach. In the knowledge transfer literature, it is widely reported that knowledge transfer is more likely to result in practice change when it is participatory and when relationships are established between researchers and research recipients. I hoped that a collaborative action research process would contribute to multi-directional dialogue and relationships between researchers, government agencies and stakeholder
groups, thereby helping build relationships needed for more effective cooperation and decision-making.

Thirdly, action research is generative and change oriented, and therefore suited to stimulating social innovation. I hoped that this project would help stimulate those who live, work, or otherwise have a stake in Ningaloo to collaboratively develop a mutual vision for applying research and managing tourism in the area, such that social, ecological and economic benefits are derived for both the local and wider communities.

Fourthly, because action research pursues situation specific knowledge, it can be applied to complex, social situations that are a complex set of relationships between indiscrete variables. This is essential given the complexity and volatility of issues associated with tourism and tourism development in Ningaloo, and the wide range of stakeholder interests and land tenures that needed to be addressed. In this case, I felt action research would serve as a convergent approach for bringing together diverse perspectives on bridging the research-implementation gap in the Ningaloo region.

Finally, because of the dialogical nature of action research, whereby the data pushes the literature (Herr & Anderson 2005), and the literature then pushes the methodology, it was well suited as a companion piece to the in-depth theoretical component of this study.

2.2.3 Modes of Analysis

Because action research does not have any prescribed methodology, action researchers must be "methodologically eclectic" (Small 1995, p.943). In this study, I applied a combination of case study and phenomenological analysis to different action research stages.

I chose the case study mode for describing and analysing the knowledge transfer activities that emerged during the course of the study. Yin (1994) states that a case study is an empirical inquiry that "investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". Case studies allow for a detailed description and analysis of a phenomenon as it emerges, from which lessons learned are drawn (Cresswell 1998).

Phenomenology is a mode of analysis that describes people’s subjective experiences, and interprets the meanings people draw from these experiences. The aim of this type of analysis is to identify the essence of an experience (Ahern 1998). Because this study aimed to describe the effects of the knowledge transfer process from the perspective of different participants, I used a phenomenological mode to analyse the stakeholder interviews conducted at the beginning and end of the project.

2.2.4 Data collection methods

Ethnography is both a process and a product (Agar 1980; Hughes 1992). As a process, ethnography is learning about a group of people (Agar 1980) who have something in common, such as cultural characteristics, a work site, a lifestyle, or a philosophy (Boyle 1994). For the purposes of this study, I used an ethnographic process to study a group of people who live, work and do research in the Ningaloo region, and who have influence over tourism and resource management decisions. I used three ethnographic data collection methods for this project: participant observation, in-depth interviews and key informants. The main features of these methods are summarised below.

2.2.4.1 Participant Observation

Participant observation combines participation in the lives of the people being studied with sufficient professional distance to allow observation and data collection (Boyle 1994). Ideally, participant observation involves the researcher’s long-term immersion (six months to several years) in the life of a group of people (Boyle 1994). For the purposes of this project, I immersed myself
Chapter 2

in the Ningaloo region by taking up residency in the area (Exmouth) for the length of the field study (18 months). The participant observation method contextualizes data and reveals the interrelationships among the various systems and subsystems in the group under study (Boyle 1994). It was therefore an important tool for exploring and navigating the dynamics between agencies and other stakeholder groups in both Ningaloo and Perth. I recorded participant observations by keeping a field journal, making electronic and voice notes, and maintaining a record of meetings and emails.

2.2.4.2 In-depth Interviews

The interview method of data collection assumes that the perspectives of others are meaningful and knowable. Interviews can be used to find out what is in and on other people’s minds; in other words, to access the perspectives of those interviewed and to find out things that cannot be directly observed (Patton 1997). Mahoney (1997) notes that in-depth interviews assume that participant perspectives are meaningful and able to affect the success of the project, and are useful when interpersonal contact and participant follow-up are important. Gathering these perspectives requires the face-to-face contact and deep insights that the interview method of data collection affords. In some cases, interviews are preferred over group data collection processes (such as focus groups or workshops), as these methods are susceptible to power dynamics.

I employed a semi-structured interview format in this study. The interview structure was designed to strike a balance between accommodating free and open responses that allow identification of complex emergent phenomena (the interpretivist component of the study), and allowing the exploration of a limited set of questions related to the study’s conceptual framework (the positivist component of the study). This was done by starting interviews with an open-ended line of enquiry. Once this line of enquiry was exhausted, a more rigid form was adopted by introducing prompts that directed the informants toward answering a short series of questions. Interviews were recorded using a digital audio recorder, and were later transcribed for analysis.

2.2.4.3 Key Informants

Mahoney (1997) describes key informants as persons or a group of persons who have unique skills or knowledge relevant to the intervention being evaluated, or who otherwise have information of interest to the researcher. They can be consulted individually, or pulled together into advisory committees that can be called to represent the ideas and attitudes of a community, group, or organization (Mahoney 1997). Mahoney (1997) sums up the use of key informants for data collection:

Key informants can help the evaluation team better understand the issue being evaluated, as well as the project participants, their backgrounds, behaviours, and attitudes, and any language or ethnic considerations. They can offer expertise beyond the evaluation team. (p.3.14)

In addition, Mahoney (1997) notes that key informants can provide advice and feedback that increases credibility of the study, serve as pipelines to pivotal groups, and help solidify relationships between evaluators, clients, participants, and other stakeholders. A key component of the knowledge broker role is to develop understanding and relationships between major stakeholders and researchers. The key informant approach is designed to achieve these results, and as such was selected as a data collection method for this study.

2.3 Design

The study design is based on a single plan-act-reflect action research cycle (detailed in Part II of this thesis), which was companioned with an in-depth multidisciplinary theoretical investigation, involving a review and synthesis of relevant concepts from the history of science and philosophy, mathematical logic, the complexity sciences and the social sciences (detailed in Part III of this

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11 See Appendices 1-4.
Chapter 2

thesis). For the planning and acting components of the action research cycle, I participated in knowledge transfer efforts between the NCC and stakeholders in the Ningaloo region. This involved embedding myself in the Ningaloo region from July 2009 to December 2010, and adopting the role of a knowledge broker. I based my role on knowledge brokering aspects identified in the literature, as summarised in Box 2.1.

From December 2010 to June 2011, I removed myself from the study area and spent time completing documentation and analysis of the results from the knowledge transfer process. I also expanded the literature review to develop a multidisciplinary theoretical investigation. I returned to the study area from July to October 2011 to conduct interviews for a stakeholder evaluation of the project outcomes. These evaluations contributed to the ‘reflect’ component of the action research cycle, which was later incorporated into the study’s theoretical investigation.

### Box 2.1. Aspects of the knowledge broker’s role (compiled from: Bialak et al. 2008; Campbell 2006; Canadian Health Services Research Foundation 2003; Dobbins et al. 2009)

- Bringing people together and building links between them
- Identifying knowledge gaps and needs and sharing ideas
- Helping information be more useful for solving problems or improving practice
- Helping people and groups better communicate and understand each other's needs and abilities
- Summarising and synthesising research and policy into easy to use and understand formats
- Transforming issues into research questions
- Ensuring research is both relevant and answering the right questions
- Encouraging the use of the research in planning, implementation and evaluation.
- Ensuring managers/policy-makers are engaged and have ownership in the research process
- Providing opportunities for stakeholders to be involved in the research process
- Navigating through sources of research
- Working to facilitate organizational change
- Eliminating barriers to research and evidence-based decision making

2.3.1 Participants

A major aim of this project was to determine whether a knowledge broker could help catalyse relationships and understanding between scientists and regional stakeholders in the course of the knowledge transfer process. Identification of stakeholders requires sorting out who or what really counts\(^\text{12}\). A stakeholder can also be understood as anyone who is affected by, or can influence, a decision or action (Dick 2002). On this basis, a purposive sampling method was applied.

I identified who key stakeholders were with the assistance of co-researchers who had long standing socio-economic research interests in the study area. My selection criteria for selecting informants from this group of stakeholders were involvement in one or more stages of a knowledge transfer process and the ability to communicate their experiences in this process. I also selected informants to provide a diversity of response that reflected the collage of stakeholder interests relevant to the area. Thus those selected included 30+ representatives from local and extra-local agencies, researchers, and affected community members, resource users, and businesses.

2.3.2 Action Research Cycle

Because a detailed description and chronology of the action research cycle is presented in Part II (Chapter 4), the description below has been limited to a simple outline.

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\(^{12}\) Gardner (2001a, citing other authors) notes that writers on stakeholder theory have always had difficulties sorting out "who or what really counts" or "To whom (or what) do managers pay attention?" He points out that stakeholders should be identified and prioritised using saliency criteria, which include power, legitimacy and urgency, or by level of power (to influence program outcomes) and interest (in the program in question).
Chapter 2

Plan: Initial Stakeholder Interviews

The first step in the action research cycle involved meeting with scientists from the Ningaloo research program (NRP) and introducing them to my proposed project. This resulted in the formation of multi-agency steering committee for this project. I followed this with an initial round of interviews to establish stakeholders’ perspectives on potential knowledge transfer barriers and opportunities. I used a semi-structured interview format and carried out interviews at a time and location of the informants’ choosing. Before commencing with the interview, I established rapport with the informant by discussing topics unrelated to the study. In accordance with Edith Cowan University’s ethics guidelines, I notified informants verbally and in writing that they were free to change or withdraw their submissions altogether, and took steps to ensure the interview results remained confidential. Interviews were recorded using a digital audio recorder.

I prompted informants with a line of inquiry beginning as such: “I would like to get your thoughts and feelings on transferring research from the science program to the people in the Ningaloo region.” Once the informant had ample opportunity to have his or her 'say', and the reasons behind his or her thoughts and feelings had been thoroughly explored, further prompts were introduced (if they had not been already been addressed by the informant), including:

• What are some of the barriers to research uptake/transfer?
• What are some of the opportunities for research uptake/transfer?
• Do you have any suggestions?

Member checks were done by giving informants copies of their themed interview transcripts to verify the adequacy of the interview, and to make changes, additions or deletions as they felt necessary. This provided some confirmation that the interviews were credible descriptions of the informants’ thoughts and feelings. Next, I collated and compiled the interview results together (anonymously) under themes into a single document. I shared this document with all those who participated in the interviews. I then used the interview results to devise a list of knowledge transfer recommendations for the NCC’s management coordination committee.

Finally, I also used the interview results for a comparison with the study’s conceptual framework (as introduced in Chapter 1 and detailed in Part II, Chapter 3), and the theoretical and case study literature identifying critical success and failure factors associated with attempts to transfer knowledge and build adaptive institutions (Chapter 1). This stage of the action research cycle served to answer my first two research questions: 1) what are the critical success and failure factors associated with knowledge transfer and building adaptive institutions, as commonly identified in the environmental management literature? and 2) what were the barriers to and opportunities for knowledge transfer in the Ningaloo region as perceived by stakeholders?

Act: Conducting Knowledge Transfer Activities

After completing the initial round of interviews and making my recommendations, I used the garnered relationships and perspectives to help broker meetings and relationships between researchers and regional stakeholders. I also participated in numerous knowledge transfer activities undertaken by the NRP, including communications planning, meetings, workshops and presentations.

As new patterns of interaction began to emerge between the different people and agencies in the region, I collaborated with NRP scientists and local stakeholders to foster emerging ideas for enhancing knowledge transfer, and to mitigate inhibiting forces that resisted these ideas.

Reflect: Documenting and Evaluating Knowledge Transfer Efforts and Effects

Throughout this study, I documented the knowledge transfer and stakeholder engagement activities that took place through my field notes, collation of meeting minutes, emails, and recorded memos.
I also collaborated with co-researchers in documenting the outcomes of the process in research reports and papers. I conducted a final round of evaluation interviews with a small subset of stakeholders, to document their perspectives on the knowledge transfer process, and document the types of knowledge that were generated by the project, based on the knowledge typology outlined by Park (1999) in relation to participatory action research (Table 3.3). A more structured interview format was followed, using the following prompts:

- What, if anything, do you know now that you did not before?
- Are you doing anything differently?
- Do you associate with anyone new or differently?
- Has your thinking or perspective on anything changed?
- What were your overall thoughts on how the knowledge transfer process went?
- Can you see other applications for this process?
- What are your thoughts on my (knowledge brokering) role?

Member checks and sharing of the anonymously compiled interview results were conducted as per the first round of interviews.

I then analysed the interview results together with the documented knowledge transfer outcomes, and compared them against the conceptual framework outlined in Chapter 3. From this analysis of the action research study, I was able to answer my third and fourth research questions: 3) what knowledge transfer processes emerged through the course of the study, and how did they affect the knowledge, perspectives, behaviours and relationships of various stakeholders? and 4) how effective was the knowledge transfer process from a stakeholder perspective?

I then synthesised the action research analyses with the theoretical investigations in Part III of this thesis. From this synthesis I was able to answer my final research questions: 5) how can the social sciences, philosophy and complexity theory contribute to our understanding of knowledge transfer in environmental management? and 6) how can these results contribute to a new framework for using knowledge transfer to help build adaptive capacity in socio-ecological systems?

### 2.3.3 Analysis

In terms of the interviews, I carried out a phenomenological thematic analysis of the reviewed informant transcripts, using a methodology based on that outlined by Colaizzi (1978). Methodological steps included reading through the interview results to get a 'feel' for the content, extracting significant phrases from the transcripts, organising the phrases into category statements selected to reflect the meaning of the phrases, and grouping category statements together into clusters of themes to highlight the themes that commonly emerged across most of the interviews. This was done by coding the phrases using NVivo (Gibbs et al. 2002). To validate the selected categories and the themes, each was referred back to supporting statements drawn from the original transcripts.

I used a holistic analysis to describe and reflect on the themes and issues that emerged as the knowledge transfer process unfolded (with special attention to the role of knowledge brokering), and how it affected the knowledge, perspectives, behaviours and relationships of various stakeholders. The phenomena that arose were compared to outcomes that were predicted by the conceptual framework. The results from these analyses were then examined in relation to the conceptual framework in Chapter 3, and the theoretical investigation component of this study (Part III).

### 2.3.4 Rigour

I established the rigour of the analysis in a number of ways. Firstly, project credibility was ensured by embedding myself in the study area for a prolonged time, conducting multiple interviews,
Chapter 2

attending numerous meetings and workshops, discussing the results with study supervisors, and collaborating with co-researchers to document the outcomes of the knowledge transfer process.

Person triangulation was achieved by collecting data from many different people and member checks were conducted by having participants comment on and approve all their draft interview transcripts. More than 40 people participated in interviews, meetings and workshops conducted over the course of the study. Theory triangulation was also achieved by applying different theories in the analysis of project outcomes.

Representativeness was achieved by ensuring that many different types of people were involved in the study, including community members, Aboriginal community members, pastoralists, scientists, recreational fishers, local government representatives, bureaucrats, members of community groups and tourism operators. Analytical representativeness was ensured by using strategies recommended by Ahern (1998): ensuring that all informants were included in the analysis, checking that examples used were from all the informants, and ensuring that the analysis included both typical and atypical data elements. The fittingness of the data was established by comparing the outcomes of this study to that of outcomes from other knowledge transfer processes documented in the literature. To ensure auditability of the study, field notes and original interview recordings and transcripts have been kept and will be maintained for five years.

In addition, Herr and Anderson (2005, p. 55-57) have identified five validity (or quality) criteria for five common action research goals. Outcome validity refers to the “extent to which actions occur, which leads to a resolution of the problem that led to the study”. Process validity refers to the extent to which problems “are framed and solved in a manner that permits ongoing learning of the individual or system”. Democratic validity refers to the “extent to which research is done in collaboration with all parties who have a stake in the problem under investigation”. Catalytic validity refers to the “degree to which the research process reorients, focuses, and energizes participants towards knowing reality in order to transform it” (Lather 1986, p.272). Finally, dialogic validity refers to the “goodness” of research, as determined through peer review. The ways in which this study’s research questions relate to these validity criteria are outlined in Table 2.2.

<table>
<thead>
<tr>
<th>Goals of Action Research</th>
<th>Quality/Validity Criteria</th>
<th>Related Research Questions for this Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>The generation of new knowledge</td>
<td>Dialogic and process validity</td>
<td>2,4,5,6</td>
</tr>
<tr>
<td>The achievement of action-oriented outcomes</td>
<td>Outcome validity</td>
<td>4</td>
</tr>
<tr>
<td>The education of both researcher and participants</td>
<td>Catalytic validity</td>
<td>3,4,5,6</td>
</tr>
<tr>
<td>Results that are relevant to the local setting</td>
<td>Democratic validity</td>
<td>2,4,5</td>
</tr>
<tr>
<td>A sound and appropriate research methodology</td>
<td>Process validity</td>
<td>4</td>
</tr>
</tbody>
</table>

2.4 Summary

In conducting this study, I worked from both positivist and interpretivist paradigms. The primary aim of the field component of this study was to describe the nature and effects of knowledge transfer between NRP researchers and stakeholders in the Ningaloo region. As such, I used a qualitative action research approach because it is flexible, participatory, change oriented and applicable to complex social situations. I applied a combination of case study and phenomenological analysis to different action research stages. I used holistic case study analysis for describing and analysing the knowledge transfer activities that emerged during the course of the study, and a phenomenological thematic analysis on the stakeholder interviews conducted at the beginning and end of the project. I used three ethnographic data collection methods for this project: participant observation, in-depth interviews and key informants. Rigour was established
Chapter 2

through person and theory triangulation, member checking data and taking steps to ensure representativeness.

In terms of design, I used action research to apply and explore an emergent knowledge brokering approach to fostering knowledge transfer in the Ningaloo region (Part II). I then companioned the action research study with an in-depth multidisciplinary theoretical investigation (Part III) to shed light on why knowledge transfer efforts in the environmental field so often fall short, and to devise a new conceptual framework for understanding and applying knowledge transfer.

The action research component of the study was based on a single plan-act-reflect action research cycle. It involved embedding myself in the Ningaloo region for 18 months and taking on the role of a knowledge broker. For the planning stage of the action research cycle, I conducted an initial round of interviews to establish stakeholders’ (scientists and locals) perspectives on potential knowledge transfer barriers and opportunities. This generated the data to answer my first and second research questions: 1) what are the critical success and failure factors associated with knowledge transfer and building adaptive institutions, as commonly identified in the environmental management literature? and 2) what were the barriers to and opportunities for knowledge transfer in the Ningaloo region as perceived by stakeholders?

After completing the initial round of interviews and making my recommendations, I initiated the action stage of the action research cycle, using the garnered relationships and perspectives to help broker meetings and relationships between researchers and regional stakeholders. I also participated in numerous knowledge transfer activities undertaken by the NCC scientists, including communications planning, meetings, workshops and presentations. As new patterns of interaction began to emerge between different people and agencies in the region, I collaborated with NCC scientists and local stakeholders to foster emerging ideas for enhancing knowledge transfer, and to mitigate inhibiting forces that resisted these ideas. For the reflection stage of the action research cycle, I collaborated with NCC scientists in documenting the knowledge transfer and stakeholder engagement activities that took place, in research reports and papers. I then conducted a final round of evaluation interviews with a small representative subset of stakeholders, to document their perspectives on the knowledge transfer process, and document the types of knowledge that were generated by the project, based on the knowledge typology outlined by Park (1999). This generated the data to answer my third and fourth research questions: 3) what knowledge transfer processes emerged through the course of the study, and how did they affect the knowledge, perspectives, behaviours and relationships of various stakeholders? and 4) how effective was the knowledge transfer process from a stakeholder perspective?

I then analysed these interview results together with the documented knowledge transfer outcomes. Finally, I synthesised the action research analyses with the theoretical component of this investigation (Part III), so as to answer my final two research questions: 5) how can the social sciences, philosophy and complexity theory contribute to our understanding of knowledge transfer in environmental management? and 6) how can these results contribute to a new framework for using knowledge transfer to help build adaptive capacity in socio-ecological systems?
PART II: THESIS

"A little knowledge that acts, is worth infinitely more than much knowledge that is idle."
—Khalil Gibran
In Part I of this thesis, I provided a review of the environmental management literature outlining the critical role of adaptive capacity—the ability to learn and adapt—in maintaining the resilience of socio-ecological systems. I established that one of the requisites of adaptive capacity identified by the literature is establishing tight feedback loops between social and ecological systems. I then established that effective knowledge transfer between science and management is a commonly identified mechanism for enhancing these feedback loops. This understanding of adaptive capacity and knowledge transfer served as my theoretical basis when I started this study. From this basis I formulated my core assumption at the study outset: that the adaptive capacity of institutions responsible for governing natural resources is reliant on their ability to respond to feedback from the socio-ecological system they are attempting to manage, and that knowledge transfer is a mechanism for enhancing such feedback.

In Part II of this thesis, I outline the conceptual framework I devised from recent environmental management perspectives on knowledge transfer, based on this core assumption (Chapter 3). I then describe the outcomes of testing that conceptual framework using an action research study in Western Australia’s Ningaloo region (Chapter 4).
"The long and entrenched legacy of separating the growth of scientific knowledge from its application has clearly been detrimental to the management of natural resources. Some have suggested that the separation has protected science from becoming biased, or losing independence and objectivity but we would strongly contend that it has been entirely unnecessary. The fragmentation of science and its separation from application are simply artefacts of scholarship. To effectively respond to the challenge of managing complex social–ecological systems, scientists cannot afford to remain detached experts who deliver knowledge to managers, but must assume the roles of collaborative learners and knowledge generators in a science–management partnership."

–Roux et al. (2006)

3.1 Introduction

Knowledge transfer and use has been researched for 50 years (Valente & Rogers 1995), across at least 14 different disciplines. Roux et al. (2006) describe knowledge transfer as the “broad banner used to describe strategies for attempting to bridge the knowledge divide between research, policy and management operations”. Knowledge transfer differs from knowledge management (see Appendix 4) as described in the social science literature, which generally refers to how an organisation creates and shares knowledge (Land & Water Australia 2006). According to Armitage et al. (2008) the environmental management literature draws on learning theory from a number of social science fields, including social learning theory (Argyris & Schön 1978), experiential learning theory (Kolb 1984), and transformative learning theory (Mezirow 2000).

Traditional approaches to knowledge transfer commonly employ the ‘pipeline model’ which focuses on establishing a one way flow of information from researchers to managers and the public. In contrast, more contemporary approaches emphasise the need for a two-way exchange of information between scientists and end-users (Campbell 2006). This has resulted in a shift from communication, whereby efforts to improve knowledge transfer are focused on packaging scientific information to make it useful and palatable to specific audiences (Bielak et al. 2008), to one of participation, whereby knowledge transfer is improved by directly engaging end-users in the research process itself (McNie 2007; Roux et al. 2006). Bielak et al. (2008) note that:

It is no longer tenable to rely on the notion of a linear progression through an orderly research process driven by scientists, to a dissemination phase driven by communication specialists, to an adoption phase in which end users (whether in policy or management) presumably apply research findings directly in their everyday activities. Rather, science must be socially distributed, application-oriented, transdisciplinary, and subject to multiple accountabilities. From a one-way linear process, science is evolving to a multi-party, recursive dialogue. (p.2)

In this chapter, I provide an overview of some recent environmental management perspectives on knowledge transfer that illustrate the shift towards participation as a means strengthening linkages between science with management, and thereby improving the likelihood of research uptake. In addition, I highlight some of the barriers that impede knowledge transfer, and the ways in which boundary organisations and knowledge brokers can help overcome these barriers by mediating the divide between researchers and managers/decision-makers. I also outline the three types of knowledge produced during participatory research: representative, relational and reflective. In concluding, I outline the role the boundary organisations and knowledge brokers can play in bridging the gap between science and management. I draw primarily on reviews compiled by Roux et al. (Roux et al. 2006), McNie (2007), Park (1999), Cash and Moser (2000) and Michaels (2009).

The purpose of this overview is to provide a conceptual framework for analysing the outcomes of the Ningaloo knowledge transfer process/action research study chronicled in Chapter 4.
3.2 Translating Knowledge into Practice

Roux et al. (2006) argue that knowledge transfer efforts that do not result in adoption, in terms of knowledge being understood and consistently used, are failures. In other words, for knowledge transfer to be effective, the knowledge must be applied in practice. In the medical world, knowledge transfer is considered ‘optimised’ when research informs practice and practice informs research (MacDermid & Graham 2009). This process consists of iterative cycles of knowledge creation and application and is described in the knowledge-to-action cycle (Graham et al. 2006). This is a clear parallel with the discourse on the adaptive management cycle referred to in the environmental management literature (see Chapter 1, Section 1.3.1.1). Land & Water Australia (Land & Water Australia 2005) present a similar conceptual model for translating knowledge into practice, which they call the practice change cycle (Figure 3.1). All of these models are based on the plan-act-reflect cycle of Lewin’s experiential learning model (Kolb 1984).

![Figure 3.1](source:Land & Water Australia 2005)

3.3 Barriers to Knowledge Transfer

The practice change cycle illustrated in Figure 3.1 indicates how information inputs are needed to inform practice at every stage of the cycle. If scientists are responsible for producing most of this information, and managers are the ones responsible for applying it, clearly strong linkages between scientists and managers are needed. Roux et al. (2006) state that unobstructed flow of knowledge between scientists and managers is essential, with success most frequently resulting from “fostering an integrated progression from research, to design, adoption, diffusion, and sustainable implementation.”

Yet despite the growing recognition that integrated and evolving knowledge systems are needed for sustainable ecosystem management, as outlined in Chapter 1, Roux et al. (2006) argue that natural resource management suffers from a long history of ‘disciplinary fragmentation’ and a gulf between scientific knowledge and its application. The authors note that they have often seen knowledge flow compromised by “misunderstandings, frustration, unhealthy forms of conflict, and significant misalignment,” and many knowledge transfer strategies (for example those used to bridge this gap between research and operations) often fall short. McNie (2007) takes the perspective that scientists, although increasing the supply of scientific information, may not be producing
information relevant to decision-makers, or may be producing the wrong kind of information that lacks any correlation with policy or decision-making needs.

In their reviews of the knowledge transfer literature, Roux et al. (2006) and McNie (2007) identify a number of barriers believed to impede the flow of knowledge between scientists and decision-makers. These challenges are summarised in Table 3.1 in relation to whether they present from the science or the management side of the problem.

Table 3.1. Barriers to knowledge transfer, from the science side and from the management side, drawn from McNie (2007) and Roux et al. (2006).

<table>
<thead>
<tr>
<th>Science-side barriers</th>
<th>Management-side barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Self-serving; lack incentives for producing useful knowledge</td>
<td>• Reward individual instead of ecosystem interests</td>
</tr>
<tr>
<td>• Arrogance</td>
<td>• Do not know or articulate needs effectively</td>
</tr>
<tr>
<td>• Do not communicate effectively with non-scientists</td>
<td>• Too caught up in day-to-day operations to reflect or plan</td>
</tr>
<tr>
<td>• Unable to contribute to values-based discussions</td>
<td>• Do not appreciate ecosystem complexity</td>
</tr>
<tr>
<td>• Lack diplomacy and negotiation skills</td>
<td>• Do not understand or appreciate scientific knowledge</td>
</tr>
<tr>
<td>• Do not appreciate or understand local knowledge</td>
<td>• Poor understanding of scientific process</td>
</tr>
<tr>
<td>• Little regard for management applications</td>
<td>• Intolerant of uncertainty; want concrete answers</td>
</tr>
<tr>
<td>• Seldom produce information that addresses real problems</td>
<td></td>
</tr>
<tr>
<td>• Work at inappropriate spatial/temporal scales</td>
<td></td>
</tr>
<tr>
<td>• Avoid interdisciplinary research</td>
<td></td>
</tr>
<tr>
<td>• Qualify research to point of being little use</td>
<td></td>
</tr>
</tbody>
</table>

Roux et al. (2006) relate many knowledge transfer failures to the widely observed historic clash between management and research cultures. From their review they identify some of the views commonly held by managers:

- Science peer-review and reward systems enforce an inward-looking, self-serving culture.
- Scientists are arrogant.
- Scientists produce fragmented information that seldom addresses “real” problems.
- Scientists do not work at appropriate or useful spatial and temporal scales.
- Scientists have little regard for application contexts, and are driven only by intellectual curiosity.
- Scientists do not communicate effectively to non-scientists.
- Scientists are unable to contribute to the value-based debate that usually governs problem solving in the real world. (Roux et al. 2006)

In contrast, they also identify commonly cited views of scientists:

- Managers work within a system that rewards organizational and individual interests rather than ecosystem interests.
- Managers have a poor understanding of scientific processes.
- Managers do not articulate their needs effectively and often do not know what they want.
- Managers are caught up in day-to-day operations, and spend little time in intellectual reflection and longer-term R&D planning.
- Managers do not appreciate ecosystem complexity. (Roux et al. 2006)
McNie likewise argues that there are major cultural differences between scientists and non-scientists that make societal participation and collaboration in science difficult. She notes that scientists and non-scientists often do not understand each other’s knowledge systems, and that prevailing western views about expert knowledge may exclude other forms of local knowledge as being legitimate. She also states that scientists may lack the skills needed for integrating local knowledge and working with non-scientists, as scientists are typically trained in ‘hard systems’ and experimental method, rather than in ‘soft systems’ approaches needed to deal with participatory processes, relationships and group dynamics. She quotes Song and M’Gonigle (2001) who state, “Working with local knowledge requires new skills, including diplomacy and negotiation and a willingness to engage the ‘other’ in a respectful manner over long periods of time” (p.986-987).

Scientist may also lack incentives for producing knowledge for decision-making. McNie notes that academic performance is most often judged by research activity and publications rather than producing relevant information for decision-making. As such, scientists may resist doing such research. She suggests that by concentrating efforts on increasing the supply of information, scientists are failing to recognize user demand and may not be producing information that is useful to decision-makers. In addition, she notes that academic structures make it more difficult to reward, and academic tenure and promotion processes tend to underestimate the value of multi- and interdisciplinary work, despite the fact that today’s problems often span disciplinary boundaries.

McNie also cites numerous authors who note that the uncertainty and probabilities associated with scientific work (because of the uncertainty and complexity of the real world) are problematic for decision-makers who prefer concrete answers, and scientists often find it difficult to translate these uncertainties into meaningful terms that the public understands. In addition, scientific work is often produced at spatial and temporal scales much larger than is needed for decision-makers (McNie 2007).

Commonly, science-management relationships are defined by contractual arrangements, whereby scientists are paid to produce a report for a management agency. In these cases, Roux et al. note that managers reduce their risk by preparing detailed contracts for commissioned research, and scientists reduce their risk by “qualifying their findings and recommendations to the point where they may be of little help to the manager.” According to Roux et al. (2006), these arrangements “don’t represent a true partnership or alliance between science and management, nor do they provide the time and space for uncovering latent needs, defining strategic direction, or jointly developing a better future.” Rather, this requires long program time frames (5-10+years), integrating knowledge needs and flows, agreeing on program outcomes, sharing ownership of the research, and establishing high levels of trust (Roux et al. 2006).

Szulanski (1996) found that the arduousness (laboriousness and distance) of the relationship between the knowledge creator and the knowledge recipient is one of the biggest barriers to knowledge transfer. This pertains to Roux et al.’s (2006) concept of the knowledge interface: the overlap between two knowledge systems (e.g. scientific and managerial). The smaller the interface, the more difficult it will be for the two groups to interact successfully. However, because the knowledge differential is larger in small interfaces, there is greater potential for knowledge exchange (along steeper gradients). Adding to the difficulty of knowledge exchange over small interfaces is the phenomenon known as ‘trained incapacity’, whereby the more a person’s perspective is shaped by his or her learning in a defined field, the more difficult it is for them to relate to knowledge and realities from other fields (Roux et al. 2006).

### 3.4 Opportunities for Improving Knowledge Transfer

Roux et al. (2006) suggest that scientists and managers have tended to adopt different strategies for bridging the divide between them, which can be grouped into ‘push strategies’ on the part of scientists—pushing new knowledge from the science domain to management, and ‘pull strategies’ on the part of managers—pulling new knowledge from science into the management domain. Roux et al. (2006) summarise ‘push’ strategies as: involving end-users in the knowledge creation
process, improving scientist credibility, and packaging information for managers (sometimes referred to as ‘knowledge translation’, whereby science is packaged according to the preference and timescales of particular audiences; see Beilak 2008). In contrast, they summarise ‘pull’ strategies as: identifying and articulating real information needs, becoming involved in ‘upstream’ activities (i.e. working with scientists to co-design research programs), and improving information seeking and filtering abilities.

The following sections outline perspectives on improving knowledge transfer drawn from two recent literature reviews. The first, by McNie (2007), deals with the concept of reconciling knowledge supply and demand, with a focus on producing useful information. The second, by Roux et al. (2006), introduces the concept of knowledge interfacing and sharing, with a focus on collaborative approaches to producing knowledge.

### 3.4.1 Producing Useful Scientific Information

McNie’s (2007) review of the knowledge transfer literature deals primarily with the ‘push’ side of the equation, from a science policy perspective. Her premise is that the science-management gap can be bridged by scientists producing information that is relevant to decision-makers.

McNie (2007, and references cited therein) outlines factors dictating whether information is ‘useful,’ from an environmental policy perspective. She states that useful scientific information “improves environmental decision-making by expanding alternatives, clarifying choice and enabling decision makers to achieve desired outcomes,” (p.17). She concludes from her review that information must satisfy three key criteria to be useful to decision-makers:

1. Salience (context specific, at the appropriate scale, timely, etc.),
2. Credibility (perceived by users as accurate), and
3. Legitimacy (free from bias or political agenda).

From her review McNie (2007, and references cited therein) also notes that scientific information not only needs to be useful in terms of content, but that it must also include a mechanism for transmitting that information from scientists to decision-makers; i.e. useful information is both content and the “product of an effective process” (p.19). Although McNie uses the term ‘mechanism’, thereby diminishing the human aspect of the knowledge transfer process, she does note that the importance of soft systems (i.e. Checkland 1981) or social capital (i.e. Putnam 1995) cannot be underestimated with respect to ensuring legitimacy of scientific information, and cites a number of researchers who have identified social capital as a prerequisite to having information used in decision-making.

McNie argues that the usefulness of scientific information can be improved by applying a concept borrowed from economics: reconciling the supply of scientific information with user’s demands, or RSD, as per Sarewitz et al. (2007). According to McNie, RSD involves a dynamic, non-linear process of interaction between users and producers of scientific information, with the goal of creating useful information for decision-makers. This approach is contrary to the traditional mainstream view that scientific research should be an independent process.

From her review of the science policy literature, McNie describes four historic trends in RSD. First was the call for increased production and dissemination of useful information by national and international agencies. Second was increasing stakeholder participation and collaborative decision-making; third, the creation of new institutions to study how information is used in decision-making; and fourth, the creation of new institutions to facilitate the transfer of information between scientists and decision-makers. The following RSD strategies summarised in McNie’s review (drawing on the references cited therein) reflect the trend toward more participation and more active management of the science and management boundary:

1. Scientists reaching out to identify the needs of decision-makers, then conducting research to meet user demands.
2. Including stakeholders in decision-making processes.
3. Improving relationships/social capital between scientists and decision-makers, via social learning etc.
4. Managing the boundary between scientific and ‘user/policy maker’ cultures.
5. Strengthening the linkages between scientists and policy-makers, e.g. via co-production and iterativity.
6. Improving communication between scientists and decision makers, particularly with respect to the concept of scientific uncertainty and translating science into common language.
7. Developing a ‘theoretic framework’ for enhancing linkages between scientists and decision-makers; e.g. social learning processes in which scientists learn alongside stakeholders and recognize that their own participation and presence in the process will affect the outcome of the entire system.

Citing others, McNie suggests that for any given situation flexible repertoires rather than recipes are required, and that the best combination of RSD strategies will be context specific. She suggests a number of mechanisms for linking science and decision-makers in aid of improving the usefulness of scientific information, including participatory processes, adaptive management, science shops, community based research and boundary organisations.

3.42 Knowledge Interfacing Between Scientists and Managers

In their review of the knowledge transfer literature, Roux et al. (2006) deal with both the ‘push’ and ‘pull’ side of the equation. Despite increasing use of the push and pull strategies described above, Roux et al. believe knowledge transfer still often fails. From their review of reasons for failures of knowledge transfer efforts, the authors believe this is because both parties fail to value the tacit dimension of knowledge—focusing instead on that which is explicit—and the need for diverse and bi-directional flow of knowledge. As such, Roux et al. take McNie’s call for increased participation by end-users as a means of improving the usefulness of scientific information a step further. Their premise is that the science-management gap is best bridged by having scientists and decision-makers collaborate to co-produce information, thereby building between them tacit knowledge, as understood in the work of Polanyi (1962) and Nonaka and Takeuchi (1995).

Knowledge can be viewed as having two dimensions: explicit and tacit (Nonaka & Takeuchi 1995; Polyani 1967). Explicit knowledge consists of information, i.e. data, interpreted data or factual statements (Drucker 2002; Kogut & Zander 1992). Knowledge, however, is more than just information—it is also that which gives people the capacity to act effectively (Dawson 2000). This capacity to act is derived from the unspoken tacit knowledge (Nonaka & Takeuchi 1995) held by an individual or organisation. Tacit knowledge is largely unspoken, “a mix of experiences, values, contextual information, and intuition that provides a framework with which to evaluate and incorporate new experiences and information,” (Davenport & Prusak 1997, p.8). When we express knowledge in facts and figures, we lose the tacit dimension of that knowledge. And when we try to codify the associated tacit knowledge (i.e. write it down), we lose its context, because we always know more than we can verbalise, and verbalise more than we write down (Snowden 2003). Because tacit knowledge is deeply rooted in an individual’s experience, it is difficult to share, requiring intimate human interaction, and time spent together building trust and understanding between individuals. As such, the actual effort needed for effective knowledge transfer is often grossly underestimated (Roux et al. 2006).

To resolve this situation, Roux et al. (2006) propose moving away from knowledge transfer and towards a conceptual framework of knowledge interfacing and sharing. They introduce the concept of the knowledge interface as the overlap between scientific and managerial knowledge systems. Some point of overlap is needed if the two distinct entities are to effectively share knowledge. This

13 McNie (2007) notes that there is little consensus on how to do this. For example, she cites Lemos and Morehouse (2005), who describe an iterative process of co-producing science policy that “emphasizes the need for assessment models to build effective internal and external networks, including the capability to sustain ongoing flows of information and participation between science and decision makers from the public, non-governmental, and private sectors” (p.61).
overlap creates a point of common understanding where scientists and managers can meet, communicate, and share and create new knowledge together.

Roux et al. state that activities within these interfaces must go beyond just exchanging information (i.e. explicit knowledge), and allow for the exchange of tacit knowledge, a much more difficult, intense, and lengthy process (where quality of the interaction is key). Thus, knowledge interfaces provides an arena for dialogue as well as the “co-evolution of values, priorities, intent and action that provide robustness to decision-making,” (Roux et al. 2006). In this way, the parties “move beyond the traditional roles of knowledge provider and knowledge consumer, to that of partners who negotiate what is feasible, desirable, and acceptable,” and begin to embark on joint fact finding as a unified learning system (Roux et al. 2006). Roux et al. suggest that initial steps in this direction could involve parties sharing details about their respective knowledge domains, such as history, spatial and temporal scales, precision, accuracy and availability.

In summary, Roux et al. (2006) argue that co-producing knowledge through collaborative learning between experts and users, and regarding knowledge as a relational process rather than a ‘thing’ (i.e. moving from explicit to tacit knowledge), will be more effective than mere knowledge transfer. This relates back to McNie’s (2007) conclusion that in order for knowledge to be useful for decision-makers it must be salient, credible and legitimate—according to McNie knowledge comes to meet these criteria when scientists work together with the knowledge end-users in participatory processes.

Roux et al. suggest that the best way to facilitate the science-management interface is through self-organised and informal communities of practice14 (as per Lave & Wenger 2001; Wenger 1998; Wenger et al. 2002), with the support of well-designed research and development programs.

3.5 Levels of Participation

The common theme in the knowledge transfer perspectives outlined above is the importance of participation and collaboration between scientists and decision-makers, in both the research process and the knowledge transfer process. However, the level of participation needed for a particular research or knowledge transfer process depends, in part, on the desired outcome of the process. Figure 3.2, adapted from Quirke by Gardner (2001b), shows the impact different levels of stakeholder participation have on communication outcomes. While conventional one-way information transfer using advertising or the media is effective at raising awareness or creating understanding, securing the involvement and commitment of stakeholders in achieving desired outcomes requires group decision-making. Thus, if the intent of a knowledge transfer exercise is to simply create awareness or understanding, conventional information-based campaigns are appropriate. As Roux et al. (2006) point out, however, knowledge transfer efforts that do not result in application of the research are failures. If the intent of knowledge transfer is to change behaviour or practice in some way, the evidence presented in the above reviews by McNie (2007) and Roux et al. (2006) suggests that participatory processes of some kind are required.

The notion that higher levels of end-user participation improve the likelihood of research application is supported by numerous other authors who likewise identify the importance of having scientists and decision/policy-makers work together to create new knowledge (e.g. Born et al. 2009; Cash & Moser 2000; Hunt & Shackley 1999; Kainer et al. 2009; Lemos & Morehouse 2005; Shackleton et al. 2009). Indeed, it is mandated in post normal science (e.g. Funfowicz et al. 1999; Funfowicz & Ravetz 1993; e.g. Ravetz & Funfowicz 1999) and sustainability planning (e.g. Meppem & Bourke 1999; Meppem & Gill 1998). In her literature review, Michaels (2009) highlights the co-production of knowledge as a way of improving knowledge transfer. She cites Innes (1998), who argues that decision-makers are more likely to use knowledge in decisions when they have been involved in the knowledge creation process, and Snowden (2006), who notes that decision-makers

14 According to Wenger (2004), communities of practice are “groups of people who share a passion for something that they know how to do and who interact regularly in order to learn how to do it better” (p.2). They are, voluntary, non-hierarchical, and largely based on informal networks, although they sometimes have support from formal organisations (Land & Water Australia 2006). Refer to Appendix 4, Section A4.7 for a more detailed review of this concept.
are more willing to act on technical information when they have had the opportunity to interact directly with the raw data (rather than relying on the interpretation of others).

Similarly, research by Chapman (2004) and Allen (2001) suggests that participatory processes can contribute to double-loop learning\textsuperscript{15}, whereby people’s governing assumptions and values are changed (Argyris & Schön 1974, 1996), leading to greater likelihood of real behavioural changes among participants and key stakeholders. Allen (2001) likewise observed that resolving environmental issues requires the commitment of those involved in the change process, which in turn is achieved when these people participate in the negotiation of issues.

Determining levels of participation in research and knowledge transfer processes also raises ethical questions around power and control. McTaggart (1997) notes that participation is a process through which stakeholders influence and share control over initiatives and the decisions and resources which affect them. As such, participatory research implies research undertaken by people, not on people. McTaggart states that the idea of participation—meaning to share or take part in—is problematic because it is often confused with involvement, meaning “entanglement or implication”. He argues that while participation implies ownership over the research process, involvement is open to exploitation and manipulation. Tandon (1988) suggests that for research to be genuinely participative, the people must have control over the whole process, including:

\begin{itemize}
  \item a role in setting the inquiry agenda
  \item participation in collecting and analysing data
  \item control over how research results are used
\end{itemize}

\textsuperscript{15} See Appendix 4, Section A4.4.2.3 for an overview of this concept.
Park (1999) states that the first principle of participatory research is that it begins with people’s problems arising from the process of day to day living, and that it “cannot be motivated by an outside expert’s senses of what ails the community” (p.144). A number of authors (e.g. Cornwall 1995; Parkes & Panelli 2001; Pimbert &Pretty 1997; Pretty et al. 1995) acknowledge that there are different levels of participation in participatory research, as per Arnstein’s (1969) seminal work on the ‘ladder’ of citizen participation. These authors describe the relations between the researcher and the community (which is comprised of more than just decision-makers) as a continuum, based on degrees of participation and partnership afforded to the community being studied, ranging from co-option to collective action. These relations are summarised by Parkes and Panelli (2001, citing others), and depicted in Table 3.2. Thus, the level to which a research program decides to involve stakeholders depends on the level of impact they wish to achieve, as per Figure 3.2, as well as ethical considerations associated with community control and empowerment.

Table 3.2. Types of participatory research (adapted from: Parkes & Panelli 2001, citing others).

<table>
<thead>
<tr>
<th>Mode of Participation</th>
<th>Involvement of local people</th>
<th>Relationship of research to people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-option</td>
<td>Token representatives chosen, but no real input or power sharing</td>
<td>On</td>
</tr>
<tr>
<td>Compliance</td>
<td>Tasks assigned with incentives, but outsiders decide the agenda and direct the actions</td>
<td>For</td>
</tr>
<tr>
<td>Consultation</td>
<td>Local opinions are sought but outsiders analyse and decide on the best course of action</td>
<td>For/with</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Local people work together with outsiders to determine priorities but responsibility remains with outsiders for directing the process</td>
<td>With</td>
</tr>
<tr>
<td>Co-learning</td>
<td>Local people and outsiders share their knowledge to create new understandings and they work together to form action plans with outside facilitation</td>
<td>With/by</td>
</tr>
<tr>
<td>Collective action</td>
<td>Local people set their own agenda and mobilise to carry it out in the absence of outside initiators, and with or without outside facilitators</td>
<td>By</td>
</tr>
</tbody>
</table>

3.5.1 Types of Knowledge Generated by Participatory Research

Drawing on the distinction between the tacit and explicit dimensions of knowledge, where the tacit leads to effective action, Park (1999) takes an even closer look at the types of knowledge generated by participatory research by applying the concepts of single and double loop learning (Argyris & Schön 1996) and orders of change16 (Bartunek & Moch 1987; Bateson 2000; Watzlawick et al. 2011). On this basis, he outlines a typology with three types of knowledge: representational, relational and reflective (Table 3.3).

Park first introduces representational knowledge, which has two sub-categories: functional and interpretive. In its functional form, representational knowledge is a ‘faithful’ quantitative depiction and explanation of reality, such that people are better able to control that reality. According to Park, this is the type of knowledge that is valued by natural sciences, often to the exclusion of all other forms of knowledge. In its interpretive form, representational knowledge is a qualitative representation of reality, in that it describes, scrutinises and codifies the meaning humans attach to objects, experiences and events. Examples include knowledge generated by hermeneutics and biblical studies. Park’s representational knowledge is the equivalent of explicit knowledge. On its own, however, representational or explicit knowledge seldom motivates people to take action, despite compelling technical arguments for doing so (see McKenzie-Mohr 2011).

16 Refer to Appendix 4, Section A4.4.2.3 (single and double loop learning) and Sections A4.4.3 and A4.5.11 (orders of change) for a review of these concepts.
Because representational knowledge separates the knower from the known, it does not generate shared understanding, as this requires that we “enter into dialogue as partners with those whom we wish to understand” (Park 1999, p.146). **Relational knowledge** is generated when we come to know another human being, such as a close friend or lover, through some form of relationship. This distinguishes relational from interpretive knowledge in that with relational knowledge “the sense of knowing involved is one of acquaintance and sharing that resides in the thick of the relationship itself, not one of depicting or portraying that person as an object of scrutiny” (p.147). As such, participatory research generates relational knowledge as scientists and participants interact and come to know each other on a personal level. The characteristics of relational knowledge—caring, sharing, commitment, trust, etc.—are common to those of social capital as described by Putnam (1995) and Coleman (1998). Park notes that in creating relational knowledge, the knower and the known merge in some form of union. As such, relational knowledge is the “foundation of community life”, in that it strengthens social capital and community ties (Park 1999, p.147). The generation of relational knowledge, or social capital, as it might also be referred to, also has an important role in facilitating the generation, sharing and validity of representational knowledge (Park 1999). This bears upon the findings of Allen (2001), who notes that while information is important, learning that results in change will only occur if information is supported by social capital. Thus, Park’s relational knowledge can be seen as an element of tacit knowledge.

Park’s (1999) third category of knowledge goes beyond the relational to incorporate the moral. **Reflective knowledge** involves right and wrong from the perspective of human values. Reflective knowledge is generated through rational deliberation in ideal speech situations (as per Habermas 1987) and through *conscientization*, the raising of both consciousness and conscience (as per Friere 1970). Participatory research creates reflective knowledge when interactions between scientists and participants lead both parties to question the premises and deep assumptions underlying their own thinking and the problems they are collectively trying to solve. According to Park, reflective knowledge is the product of double loop learning (Argyris & Schön 1996), and can create second order change, whereby seemingly intractable problems are resolved by changing the rules and premises governing the system in which the problem is embedded (Watzlawick et al. 2011, see Appendix 4, Section A4.4.3). Thus, reflective knowledge is bound up with action: it “instils conviction in the knower, and the courage to go with it, and commits him or her to action,” and as more people act, reflective knowledge grows in strength (Park 1999, p148). Generation of reflective knowledge also requires that people be connected through relational knowledge. As such, reflective and relational knowledge can together be understood as tacit knowledge—that which gives people the capacity to act.

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17 Park (1999) notes that the generation of reflective knowledge presupposes that participant discussions are taking place in an environment free of hidden political agendas and oppressive power relations. Thus, in reality, to goal of achieving reflective knowledge is only partially realizable.
According to Park, all three of these forms of knowledge “reinforce and interact with one another” (p.149). Representational knowledge is increasingly shared and understood as scientists and participants come to know, like and trust each other through their interactions, thereby generating relational knowledge. As relational knowledge builds through successive deliberations, this leads to the generation of reflective knowledge, as both participants and scientists begin to question the premises and assumptions underlying their own thinking and that of the problem at hand. This helps generate conviction and courage among all parties to instigate systemic changes (second order change) toward solving the difficult problems they are collectively addressing.

### 3.6 Participatory Research Approaches

Based on Park’s (1999) typology of knowledge, one can see that generating and transferring representational knowledge is unlikely on its own to lead to research application in practice, without which knowledge transfer is considered a failure (as per Roux et al. 2006). Rather, participatory processes encouraging repeated reciprocal interactions between researchers and managers/decision-makers are needed to also generate the relational and reflective (i.e. tacit) knowledge that lead to commitment and action. This is related to Roux et al.’s (2006) notion of knowledge interfacing, whereby linkages between scientists are strengthened through collaborative co-production of knowledge. It also related to McNie’s (2007) notion of RSD, whereby scientific information is made useful for decision-makers via a process of dynamic interaction between scientists and end-users.

The following provides an overview of some selected participatory research approaches that involve levels of collaboration between scientists and decision-makers, within the context of research programs. These include: communities of practice, and research for development programs, social learning and extension.

#### 3.6.1 Communities of Practice

Roux et al. (2006) suggest that informal, self-organising communities of practice\(^{18}\) (CPs) present the easiest way of facilitating the interface between science and management, given their focus on knowledge, rather than official mandates and rules of membership (Lave & Wenger 2001; Wenger 1998; Wenger et al. 2002; see Appendix 4, Section A4.7). However CPs run the risk of having insufficient resources, whereas research and development (R&D) programs can help form and maintain communities of practice by providing much needed resources (Roux et al. 2006). To avoid being either too research driven, or too management driven, R&D programs must generate dialogue between the science and management domains so a negotiated view of what is “both feasible and desirable” emerges (Roux et al. 2006). Roux et al. (2006) also note that too many natural resource research programs employ a “strategy of hope” (hoping someone will use their research), or rely on formal structures and traditional modes of communication that are ineffective. They argue that “well-designed natural resource R&D programs will place much more emphasis on creating an environment conducive to promoting a self-organising CP that fills an important role in fostering bi-directional flow in the knowledge interface” (Roux et al. 2006). The authors further argue that R&D steering committees typically initiate an array of projects covering their own information needs, and become focused on “short-term time frames and fragmented outputs.” Outputs are items such as reports and publications; they are not ‘outcomes’, which refer to changes in management practices and/or improvements in the resource itself that occur as a result of knowledge application from the R&D program.

As such, if R&D programs are to move beyond just generating a range of outputs to effecting change in management practice, they will have to “step beyond their disciplinary comfort zones” (Roux et al. 2006). This means shifting focus from transferring explicit knowledge (i.e. information), to creating tacit knowledge (relationships, social capital, capacity for action), the

\(^{18}\) According to Wenger (2004), communities of practice are “groups of people who share a passion for something that they know how to do and who interact regularly in order to learn how to do it better” (p.2). They are, voluntary, non-hierarchical, and largely based on informal networks, although they sometimes have support from formal organisations (Land & Water Australia 2006).
essential ingredient for effecting practice/behavioural change. Supporting informal CPs, with their networks of relationships and freedom from bureaucratic constraints, is an effective way of achieving this (Roux et al. 2006).

3.6.2 Research for development

Ashby (2003) states that researchers now approach innovation and their role in natural resource management in a new way. She argues that researchers need to recognize that the management impact of their research depends on their relationships with other stakeholders, “who may have more power to visualize and to realize the desired outcomes of interventions than the researchers do.” She introduces the concept of ‘research for development’, contrasting it with ‘research and development’ programs:

Research and development’—also known as R&D—derives from the concept of researchers who are in control of a pipeline for producing technological innovations: an idea goes in at one end of the pipeline, research develops a prototype, and then a fully developed product comes out, ready to be released to eager users, at the other end of the pipeline. In contrast, ‘research for development’ emphasizes the iterative, adaptive nature of innovation in complex ecosystems, which is achieved through systematic enquiry combined with learning based in action. (Ashby 2003, p.1)

As such, participation of relevant stakeholders in the research process (including its management) is a key feature of ‘research for development’, and is directly relevant to research quality and impact. Ashby (2003) describes participatory research as “a collection of approaches that enable participants to develop their own understanding of and control over the processes and events being investigated.”

Citing others, Ashby (2003) argues that when research organisations are based on non-participatory models (i.e. conventional research and development) “most of the innovative research is done by an informal, or ‘shadow’, organization that develops as a way of circumventing the outmoded rules of the formal organization” (p.13). In contrast, a research program that applies the principles of ‘learning organisations’, as per Senge’s (1990) approach to improving the adaptive capacity of businesses, and conducts research for development, will see rapid adoption of innovations (Ashby 2003).

3.6.3 Social Learning & Collaborative Planning

Since the 1970s, with increasing calls for public participation in resource management, social learning has become a popular idea in the environmental management literature19 (Pahl-Wostl et al. 2007; Tábbara & Pahl-Wostl 2007). It is based on constructivist20 views of learning as a process of social interaction (Kilvington 2007). The rise of social learning approaches in resource management reflect a paradigm shift from expert-driven decision-making, where technical experts make decisions for everybody, to more collaborative decision-making approaches that recognise that resolution of complex, uncertain environmental problems requires the coordinated effort of diverse stakeholders (e.g. Dryzek 1997; Pahl-Wostl et al. 2007).

While social learning often refers to concepts from the organisational learning literature such as single and double learning (e.g. Ison & Watson 2007; Pahl-Wostl et al. 2007), according to Schusler et al. (2003) the term nonetheless lacks a common theoretical perspective, and has been something of a catch-all to describe a variety of learning activities that occur as a result of public or group deliberation during resource decision-making. Social learning generally is seen to have two aspects: learning and action, which occur as stakeholders are brought together to learn and make decisions about complex problems (Kilvington 2007). According to Friedmann and Abonyi, (1976):

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19 Not to be confused with the original meaning of social learning in the psychology literature, where it denotes the propensity of people to imitate others, as outlined by the work of Albert Bandura in the 1960s.

20 See Appendix 4, Sections A4.4.3 and A4.7 for more detail on constructivist views.
Social learning occurs in a setting of social practice, which might be thought to be composed of four dynamically interrelated processes: the formulation of a theory of reality, the articulation of relevant social values, the selection of an appropriate political strategy, and the implementation of practical measures or social action. (p.929)

This is similarly reflected in Schusler et al.’s (2003) definition of social learning as “learning that occurs when people engage one another, sharing diverse perspectives and experiences to develop a common framework of understanding and basis for joint action,” (p.311). Ison and Watson (2007), however, focus on the action dimension of social learning, describing it as “achieving concerted action in complex and uncertain situations.” As such, social learning is more than just learning; it is also a means of facilitating collaborative management of resources (i.e. action), by transforming adversity and establishing trusting, cooperative relationships (Schusler 2003). Social learning also brings together the diverse perspectives needed to understand how complex social and ecological systems function as a whole, and builds adaptive capacity within governance systems so they are better able to cope with uncertainty and change (Folke et al. 2003). Social learning can be further improved by recognising the diversity of mental models that influence decision-making, and by building a shared representation of problems at hand through participatory modelling (Tabara & Pahl-Wostl 2007). Tabara and Pahl-Wostl (2007, and references cited therein) present a number of criteria for social learning:

1. Opportunities for mutual reflection on underlying assumptions and frameworks.
2. Capacity to reflect on assumptions, dynamics and values of cause and effect relationships in the system.
3. Participatory, democratic and multi-scalar decision-making processes
4. Individual and institutional capacity to spontaneously develop polycentric forms of resource management.
5. Empowerment of individuals and social movements to become involved in decision-making.
6. Recognition of mutual interdependence and interaction of actors in the system.
7. Active engagement of individuals in collective decision-making processes.

Social learning is strongly related to work in the field of communicative or collaborative planning, whereby the role of planning or the planner is that of facilitating communicative interchanges between stakeholders, fostering community empowerment and deliberating about shared futures (Huxley & Yiftachel 2000). Notable contributions to this field include that of Friedmann (1987), Innes (1998), Healy (1997), and Sandercock (1998), whose ideas have been applied to environmental management and sustainable development by a number of authors (e.g. Dryzek 1997; Meppem 2000; Meppem et al. 2005; Meppem & Bourke 1999; Wondolleck & Yaffee 2000). The development of communicative planning is paralleled by the development of socio-ecological resilience thinking (Goldstein 2009), which emphasises the role of participatory governance and aggregating knowledge from diverse perspectives (e.g. Berkes & Folke 2002b; Folke et al. 2005; Gadgil et al. 2003; Gunderson & Holling 2002; see Chapter 1, Section 1.3.11).

3.6.4 Extension

Extension is a non-formal, active learning process involving dialogue between specialists and novices as a way of solving local resource management problems (i.e. it creates knowledge exchange between these two parties). According to Röling (1988), participation is the basis of extension-oriented approaches to education, which are guided by the following principles:

• stakeholders are motivated by the need to solve a local environmental problem
• focus should be on non-formal processes that establish a dialogue between specialists and novices
• stakeholders must become actively engaged in identifying and implementing solutions (Röling 1988).
Chapter 3

For example, in the U.S. an agricultural research, education, and extension system was established to improve the links between science and decision-making across multiple scales (Cash 2001). Landcare in Australia is another example of extension. Landcare works as an “interconnected flexible web of relationships for effective communication, information dissemination, knowledge generation and local knowledge brokering relating to NRM issues” (Beilin & Reichelt 2010, p.33). Effective functioning of Landcare relies on these webs extending to other groups beyond the immediate Landcare community to allow for new ideas and opportunities. Beilin and Reichelt (2010) also note that Landcare networks generate social capital by establishing trust, social bonding, reciprocal relationships, and common norms and practices.

Landcare in Australia has shown adaptive capacity in a number of ways: the formation of communities of practice consisting of a range of landholders, collective delivery of market-based instruments, on-the-ground action related to natural resource management priorities, and the engagement of agriculture companies in environmental work (Beilin & Reichelt 2010).

3.7 Boundary Spanning & Knowledge Brokering

Attempting to improve participation and collaboration in the research or knowledge transfer process can, however, be challenged by the cultural barriers (outlined in Section 3.3) that impede relations and knowledge flow between scientists and decision-makers. Because scientists and decision-makers alike may lack the time, resources, aptitude and skills to overcome these barriers, it may beneficial to engage the assistance of organisations or individuals who can help span the divide between the two groups, by brokering relationships and fostering collaboration. The following sections provide an overview of the way two such entities, boundary organisations and knowledge brokers, are represented in the literature, drawing largely on papers by Cash and Moser (2000) and Michaels (2009).

3.7.1 Boundary organizations

Cash and Moser (2000, and references cited therein) suggest that when scientists and decision-makers meet, they struggle with “maintaining scientific credibility while assuring political saliency,” (p.114). This contested divide between science and policy can be viewed as a “fuzzy, dynamically shifting and jointly created and maintained boundary” (p.114). Such a boundary is socially constructed, and must be actively managed by both scientists and policy makers if it is to be bridged (Michaels 2009, and references cited therein). Boundary organisations can help bridge this gap between science and policy. They do so by serving as honest brokers, being accountable to both sides of the boundary (McNie 2007), and facilitating multi-directional flow of information between scientists and decision-makers (Cash & Moser 2000). This includes producing boundary objects, salient information that is relevant to both sides of the boundary, and which can be used in decision-making, such as reports, models, newsletters, etc. (Cash & Moser 2000, and references cited therein). Boundary organisations not only work to bridge the science-policy divide (Cash 2001), they also link science and policy across local, state, national, and international levels, thereby mediating the “convergence of interests, ideas, disciplinary languages and perspectives at different scales” (Cash & Moser 2000, p.115). Cash and Moser (2000) summarise the functions of boundary organisations as: information brokerage (translating information across scales), communication of salient research needs to scientists, insulation from political pressures emanating from across the boundary, providing neutral fora for discussion, and long-term trust-building. As such, the boundary organisation becomes a medium through which science and policy domains can generate works that are important and credible to all parties (Cash and Moser 2000, Michaels 2009, drawing on references cited therein).

Cash and Moser (2000) suggest that boundary organisations are a “powerful alternative” (p.114) to the traditional pipeline model of knowledge transfer. In the boundary organisation model, decision-makers are participants rather than just information recipients, actively creating relationships with scientists, producing scientific outputs, and maintaining the science-policy boundary. According to McNie (2007, p.22, citing references therein) this requires a new social contract for science, one that is based on collaborative assurances. However, Michaels (2009, and
others cited therein) notes that “while boundary organizations are increasingly, if uncritically in
vogue, little consensus exists about how to bridge the science and policy divide,” (p. 996).

3.7.2 Knowledge Brokers

3.7.2.1 Knowledge brokering defined

Knowledge brokering refers to actions taken by people to promote knowledge exchange and
adoption. Aspects of a knowledge broker’s role are outlined in Box 2.1 (Chapter 2). In particular,
knowledge brokering involves encouraging decision-makers to use research, and researchers to
undertake research relevant to decision-making (Michaels 2009, citing references therein). According to Campbell:

Knowledge brokering is typically used to refer to processes used by intermediaries
(knowledge brokers) in mediating between sources of knowledge (usually science and
research) and users of knowledge. Knowledge brokering is usually applied in an attempt to
help knowledge exchange work better for the benefit of all parties. (Campbell 2006, p.15)

Knowledge brokering is socially focused—it recognises that human intermediaries are needed
between the worlds of research and action, and “human interaction as the engine that drives
research into practice” (Lomas 2007, p.130). As such, Lomas (2007) describes knowledge
brokering as:

…all the activity that links decision makers with researchers, facilitating their interaction so
that they are able to better understand each other’s goals and professional cultures,
influence each other’s work, forge new partnerships, and promote the use of research-
based evidence in decision-making. (Lomas 2007, p.13)

Thus the core role of the knowledge broker is to connect people for sharing and exchanging
knowledge (Canadian Health Services Research Foundation 2003). In her review of the knowledge
brokering literature, Michaels (2009) states that knowledge brokering is also related to the notions
of boundary organisations and communities of practice, and is sometimes referred to as ‘boundary
spanning work’. For example, when working on a common problem, knowledge brokers can help
span boundaries and facilitate the flow of information between multi-disciplinary teams,
organisations and communities of practice, via translation, coordination and negotiation.
Knowledge brokers also have a role in explaining and ‘translating’ boundary objects (Michaels 2009,
and references cited therein).

McNie (2007) states that knowledge brokering can be used to help develop policy solutions for
environmental problems by bringing expertise to the table that would not otherwise be
incorporated by decision-makers. In her review, Michaels (2009) notes that this is particularly the
case where there is considerable scientific uncertainty and therefore a need to fill information gaps
and structure and interpret existing scientific information. She also suggests that knowledge
brokers are useful when decision-makers do not have the time or background to synthesise the
original research, and when there is no scientific community available to offer advice (Michaels
2009, citing references therein). In addition, knowledge brokers can play an important role in a
world where people often apply the first usable piece of information they access, rather than the
best information (Michaels 2009, citing references therein). Michaels also suggests that knowledge
brokering can help facilitate learning and interaction between polarised stakeholders when dealing
with contentious problems.

3.7.2.2 Knowledge brokering strategies

Citing others, Michaels (2009) argues that there is increasing recognition that science does not
“effortlessly or automatically become a consideration in policy making,” (p.999). She brings
Snowden’s (2006) work to bear, noting that conveying the relevant information to the right people
does not necessarily mean action will be taken. Moreover, Michaels (2009) argues that because
decision-makers are subject to different kinds of external pressures and learning styles, different
approaches to knowledge brokering are needed for environmental policy-making. She outlines six strategies—informing, consulting, matchmaking, engaging, collaborating and building adaptive capacity—ordered in increasing relationship intensity in Table 3.4.

Table 3.4. Spectrum of knowledge brokering strategies (adapted from: Michaels 2009).

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Intent</th>
<th>Examples of brokering techniques</th>
<th>Examples of how brokers can intervene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inform</td>
<td>Disseminate content</td>
<td>Fact sheets; websites</td>
<td>To targeted decision makers; disseminate fact sheets, circulate addresses of web sites with a brief explanation of their potential utility</td>
</tr>
<tr>
<td>Consult</td>
<td>Seeks out known experts to advise on problem delineated by party seeking counsel</td>
<td>Meetings; solicited assessments</td>
<td>Identify which decision makers would benefit from talking with which experts and facilitate the appropriate form of communication; work with decision makers and those with the needed substantive expertise to frame what should be included and how to present the findings</td>
</tr>
<tr>
<td>Match make</td>
<td>Identify what expertise is needed, who can provide it and the best ways to make the connections</td>
<td>Introduce people to each other who would not otherwise meet</td>
<td>Identify sources of information, locate or create materials useful in decision making and pass it on</td>
</tr>
<tr>
<td>Engage</td>
<td>One party frames the discussion through terms of reference and for the life of the required decision making process, involves other parties in the substantive aspects of the problem on an as needed basis</td>
<td>Royal commissions: technical committees, secondments</td>
<td>Identify who needs to be engaged and how</td>
</tr>
<tr>
<td>Collaborate</td>
<td>Parties jointly frame the process of interaction and negotiate substance to address a distinct policy problem</td>
<td>Joint agreement</td>
<td>Facilitate collaboration</td>
</tr>
<tr>
<td>Build capacity</td>
<td>Parties jointly frame process of interaction and negotiate substance with intent of addressing multiple dimensions of a policy problem while considering what can be learned from doing so that is applicable to implications of the issue, future scenarios and related concerns</td>
<td>Co-management; joint fact finding; co-production of knowledge</td>
<td>Steward long-term professional relationships, ensure institutional relationships</td>
</tr>
</tbody>
</table>

Although informing and consulting can take place through impersonal exchanges of information, as one moves from matchmaking through to building capacity, more face-to-face interaction and collaboration is required (Michaels 2009). This is in line with Gardner (2001b, Figure 3.2), and Snowden’s (2003) arguments that verbal interaction exchanges more knowledge than written information (because people will say more than they will write down), particularly the tacit knowledge that is most likely to lead to actual behavioural change.
Michaels (2009) argues that an intensive, interpersonal, iterative approach to knowledge brokering is needed to create and sustain the capacity for innovation. She states that since problems and their contexts are continually changing, “what is achieved through any form of brokering may be ephemeral unless it is constructed as part of an ongoing capacity building initiative,” (p.999). Citing others, Michaels suggests that the emotions, side-bar conversations and casual interaction associated with face-to-face contact help people adapt quickly to changing contexts. She concludes by stating:

Whatever form it takes, knowledge brokering is a means to an end—improved decision making. As such those who engage in it need to consider how to ensure impact by changing the wider institutional context. In bringing about change, context is as essential as the initial activity. (Michaels 2009, and references cited therein, p.999)

Despite increasing espousal of using knowledge brokering to help science inform environmental decision-making, little is known about the actual activities that knowledge brokers undertake including how they undertake communicating, mediating, translating, and fostering participation (McNie 2007, Michaels 2009). This makes it difficult to account for their contributions. However, Dobbins et al. (2009) outline a number of lessons learned about knowledge brokering in their study:

1. Early one-on-one contact was essential to developing relationships with participants and setting the stage for following activities.
2. The importance of establishing a mechanism (such as a network) to promote interaction and knowledge sharing among participants
3. Knowledge brokering is more complex than expected, and requires a lengthy process to develop collaborative and trusting relationships between participants.
4. A great deal of face-to-face interaction is required between the knowledge broker and participants as a means of developing relationships, tailoring interventions and building capacity.

The knowledge broker must be cognizant of political and organisational changes, confidentiality issues, competing interests and priorities and turf issues between organisations.

### 3.7.2.3 Knowledge brokering skills & attributes

Knowledge brokers need a specialised set of skills. Firstly, the knowledge broker must be comfortable in operating and conversing in both the scientific and management worlds (Bielak et al. 2008). Secondly, they must be skilled in interpreting and applying research, so they are able to understand and extract relevant information from research findings and tailor it into appropriate language and key messages for the target audience (Bielak et al. 2008; Dobbins et al. 2009). And thirdly, knowledge brokers need trans-disciplinary skills (Roux et al, 2006), so they are able to span knowledge disciplines, pragmatic concerns, planning and political concerns, values, ethics and philosophies (Max-Neef 2005). A list of knowledge brokering skills and attributes, sourced from Dobbins et al. (2009) and Lomas (2007), is summarized in **Box 3.1**.

### 3.8 Conceptual Framework

This review served to inform the conceptual framework devised for the action research component of this study. The central tenet of this framework is that knowledge transfer is more successful (in terms of resulting in research application) when it involves significant engagement and relationship building between researchers and research recipients (i.e. stakeholders—managers, decision-makers, community members, etc.). Greater stakeholder participation and collaboration in the knowledge transfer process will increase the generation of tacit (i.e. relational and reflective) knowledge, and help harmonise the ‘push strategies’ of scientists with the ‘pull strategies’ of managers. This in turn will increase the likelihood of stakeholders taking up and applying explicit (i.e. representational) scientific knowledge (as per Roux et al. 2005). It will also increase the salience, credibility and
Chapter 3

legitimacy of the scientific information produced, and therefore its usefulness and application by stakeholders (as per McNie 2007). As such, participatory research approaches—such as communities-of-practice, research for development, social learning and extension—should have higher rates of research application than more conventional approaches with limited engagement between researchers and recipients.

Cultural barriers impeding collaboration and relationship-building between scientists and non-scientists/managers (Table 3.1) can be overcome by employing a knowledge broker with the skills and attributes needed to mediate and broker relationships between the two groups. Boundary organisations can likewise fulfil this role. The relationships between these variables and outcomes are illustrated in Figure 3.3.

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<td><strong>Attributes</strong></td>
<td><strong>Skills</strong></td>
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<tr>
<td>Trusted</td>
<td>Interpersonal</td>
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<td>Credible</td>
<td>Communication</td>
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<td>Entrepreneurial (networking, problem solving, innovating)</td>
<td>Mediation</td>
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<tr>
<td>Diplomatic</td>
<td>Gathering, evaluating and synthesizing evidence</td>
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<td>Motivational</td>
<td>Team building</td>
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<td>Sensitive to both research and decision-making environments</td>
<td>Adult learning</td>
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<td>Research &amp; management expertise</td>
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3.9 Summary & Conclusions

Knowledge transfer refers to the spectrum strategies used to bridge the gap between research, policy and management. Knowledge transfer is not considered to be successful unless it results in adoption of research in practice. Knowledge transfer is optimised when research informs practice, and practice in turn informs research. This requires strong linkages between scientists and managers. But the flow of research to practice has been compromised by disciplinary fragmentation. As such, the literature identifies numerous barriers that impede the knowledge flow between scientists and managers. Many of these relate to cultural clashes between managers and scientists. Others relate to the arduousness of the relationship between researchers and research recipients, the failure of scientists and non-scientists to understand each other’s knowledge systems, scientists lacking the necessary skills and/or incentives to work with non-scientists, the difficulty managers have with the uncertainty of scientific work, and contractual arrangements that prevent true partnerships between science and management. Despite the increasing use of research ‘push’ and ‘pull’ strategies by researchers and managers, knowledge transfer efforts still frequently fail.

Two significant reviews of the knowledge transfer literature identify opportunities for bridging this divide between scientists and managers and improving knowledge transfer. McNie (2007) suggests reconciling the supply of scientific information with user demand (RSD) as a means of improving knowledge transfer. This requires producing scientific information that is useful (salient, credible and legitimate) to policy makers, and including a mechanism for transmitting information to decision-makers. This involves applying strategies that connect researchers and decision-makers, using methods such as participatory processes, adaptive management, community-based research and boundary organisations. She sees the RSD trend as having moved from information dissemination to stakeholder participation to creation of knowledge transfer institutions.
Figure 3.3. The conceptual framework devised at the outset of this study, from recent perspectives on knowledge transfer in the environmental management literature. As engagement between scientists and stakeholders increases, so do tacit knowledge and the salience, credibility and legitimacy (i.e. usefulness) of the research. This also helps harmonise the ‘push strategies’ of scientists with the ‘pull strategies’ of managers. The result is an increased likelihood that stakeholders will apply research. Knowledge brokers and boundary organisations can help catalyse relationships and overcome the barriers impeding engagement.
Roux et al. (2006) believe the divide can be bridged by knowledge interfacing and sharing, which creates a common space of understanding where the scientific and managerial knowledge systems overlap. They argue that knowledge transfer is best achieved when managers and researchers form a “unified learning system”, such as a community of practice that works together to create new knowledge. They suggest that research and development programs should emphasise building relationships between scientists and managers, instead of placing emphasis on producing outputs such as reports.

Both these reviews indicate that increased participation and collaboration between researchers and managers/decision-makers is the key to successful knowledge transfer. However the level of participation appropriate for a particular research programs depends on the level of research impact desired. General awareness can be achieved using more traditional one-way communication approaches, whereas commitment and action require a high level of stakeholder participation (Gardner 2001b). Determining levels of participation also raises questions of ethics and control. Types of participation can range from co-option to collective action, depending on the degree to which stakeholders control the research agenda and process (Parkes and Panelli 2001).

Park (1999) identifies three types of knowledge that can be produced during participatory research and which evoke different levels of behavioural change. Representational (or explicit) knowledge consists of facts and figures, and seldom results in practice-change on its own. Relational and reflective knowledge, which together comprise tacit knowledge, are generated as scientists and stakeholders build trust and relationships, and begin to reflect on their underlying assumptions. From relational and representational knowledge emerges people’s commitment to act, and thereby a greater likelihood that representational knowledge will be applied in practice.

There are a number of participatory approaches to research that involve collaboration between scientists and decision-makers/stakeholders. Examples include: communities of practice, informal learning networks that bring together scientists and practitioners; research for development, which involves stakeholders in the research process; social learning, which integrates research with collaborative decision-making processes; and extension, whereby novices and experts solve local problems together.

Undertaking participatory approaches to research and knowledge transfer can, however, be challenged by the cultural barriers that impede relations and knowledge flow between scientists and decision-makers. Boundary organisations and knowledge brokers can help overcome these barriers by fostering relationships and collaboration between the two groups. Boundary organisations assist by facilitating the multi-directional flow of information between researchers and decision-makers, and translating research for policy and decision-making (Cash & Moser 2000). Knowledge brokers can be used to connect people for the purposes of sharing knowledge. They do this by facilitating relationships, identifying knowledge gaps, translating research, and ensuring research is relevant to users. Michaels (2009) outlines six knowledge brokering strategies—informing, consulting, matchmaking, engaging, collaborating and building adaptive capacity—ordered in increasing relationship intensity and resultant impact on end-user behaviour. Face-to-face interaction and trust building are important aspects of the knowledge brokering process. As such, knowledge brokers require considerable interpersonal and communications skill, in addition to being credible, trusted, diplomatic and motivational.

This overview demonstrates how knowledge transfer has recently shifted away from traditional approaches involving one-way communication of information, to an emphasis on strategies and processes that encourage participation and relationship building between scientists and decision-makers. This summary and Figure 3.3 together serve as a conceptual framework for the action research component of this study. In the next chapter, the Ningaloo knowledge transfer process is chronicled as an action research study, and its outcomes analysed against this conceptual framework.
“Sustainability, is better seen as a measure of the relationship between the community as learners and their environments, rather than an externally designed goal to be achieved”

4.1 Introduction

Part of understanding why knowledge transfer efforts so often fall short requires trialling new approaches to narrowing the research-management gap. In Chapter 3, I presented a conceptual framework for knowledge transfer premised on the notion that knowledge transfer is more likely to be successful when it involves high levels of stakeholder engagement (Figure 3.3). Engagement is presumed to increase the generation of tacit knowledge, which in turn increases the likelihood of scientists producing useful information and stakeholders taking up and applying explicit scientific knowledge. Using a knowledge broker to facilitate interaction between scientists and stakeholders can enhance the engagement process by helping overcome cultural barriers between the two groups.

Between 2006 and 2011, over 50 research projects on Western Australia’s Ningaloo Marine Park were undertaken by the Ningaloo Research project\(^{21}\) (NRP). These studies ranged in scope from the biophysical to the socio-economic. The NRP centre-piece was a suite of modelling tools that synthesised the research results from all these projects into computer models. These models were intended to serve as decision support tools that would allow decision-makers to explore different management scenarios for the region. In 2010, the modellers involved in these projects initiated a series of knowledge transfer activities in the Ningaloo region, with the aim of encouraging local stakeholders to apply the NRP’s research and modelling tools during decision-making.

As such, the NRP presented an excellent opportunity for conducting an action research study on knowledge transfer. I took up this opportunity with the aim of testing the conceptual framework outlined in Chapter 3, while also (hopefully) enhancing the NRP’s knowledge transfer efforts in the Ningaloo region. This involved taking on the role of a knowledge broker by embedding myself in the Ningaloo community for 18 months and collaborating with NRP modelling researchers and local stakeholders on knowledge transfer activities.

In this chapter, I chronicle the knowledge transfer processes that emerged through the course of this action research study and evaluate the outcomes of these processes using the methodology outlined in Chapter 2. In particular, I test the conceptual framework in Chapter 3 by examining:

- Knowledge transfer barriers and opportunities in the Ningaloo region, as perceived by stakeholders;
- The effectiveness of the knowledge transfer process and the knowledge brokering role from a stakeholder perspective; and
- The outcomes of the knowledge transfer process in terms of its effects on stakeholders’ knowledge, relationships, perspectives, and behaviours (i.e. representational, relational and reflective knowledge).

\(^{21}\) The NRP is a research program jointly undertaken by the Ningaloo Collaboration Cluster (NCC) and the Western Australian Marine Science Institute (WAMSI). See Chapter 1, Section 1.1 for details.
Chapter 4

4.2 Background

The Ningaloo Reef is Australia’s largest fringing coral reef. It stretches along 300 km of coastline, between Carnarvon and Exmouth. The region (Figure 4.1) is relatively remote. Most of the land is pastoral lease and approximately 8,000 residents live in the towns of Carnarvon, Exmouth and Coral Bay. The area is noteworthy for its outstanding natural and scenic values, particularly with respect to the marine environment. It contains Ningaloo Marine Park and Cape Range National Park, and has recently been listed as a World Heritage Area.

4.2.1 Environmental Context

The Ningaloo region has been the subject of intense national and international scientific interest for over 20 years because of its significant biological and geomorphological values (World Heritage Consultative Committee 2004). Its 300km fringing reef is one of best positioned reefs in the world for surviving ocean-warming and sea level change (99% of the world’s reefs are now undergoing bleaching), because it is naturally ‘air conditioned’ by cold upwellings. With over 300 species of coral, the reef may have the highest coral diversity in the world. In addition, the area is home to over 700 species of reef fish, 155 sponge species (most of which are new to science), 600 crustacean species, 20 whale and dolphin species, 24 species of ray and shark (including one ray new to science), four species of sea turtle, a 1000-strong population of globally-threatened dugongs, and the world’s largest aggregation (300-500) of whale sharks (Simpson & Waples 2012; World Heritage Consultative Committee 2004).

Exmouth Gulf, on the east side of Northwest Cape, is home to one of the best-preserved mangrove systems in the world, and is the basis of a successful commercial prawning industry. Twice a year, 20,000 humpback whales migrate past Ningaloo. Exmouth Gulf is a resting place for these migrating humpbacks and has the highest density of humpback whales in the southern hemisphere (one per square km in 2008). The Gulf is an especially important resting place for cows and calves, as calves must fatten up here so they can make the trip to Antarctica (Lynn Irvine, pers. comm.). In addition, the karst caves of Cape Range are habitat for 80 subterranean species (stygofauna and troglobites), including blind eels, shrimp, spiders and fish. 95%-100% of these species are found nowhere else, and it is the largest diversity of subterranean life known on earth. Many of these species are relics from the time when Australia was part of Gondwanaland 20 million years ago and covered in rainforest. These species survived the drying climate by going underground (World Heritage Consultative Committee 2004). For Cape Range National Park alone, 630 plant species have been recorded, twelve of which are found nowhere else in the world. The scrubland along the Ningaloo coast is part of one of the Global 200 Ecoregions, which identify where the earth’s natural features are most distinctive and rich (World Heritage Consultative Committee 2004).

At present, recreational fishing represents the greatest risk to the region’s marine ecology and already depleted fish stocks; recent research and modelling indicates the recreational fish catch is at least equal to the region’s commercial fish catch, and potentially as much as double (Beth Fulton, pers. comm., in Jones et al. 2011). As tourism development and coastal access increases in the region, and as population and visitation increases as a result of spin-off from oil and gas development in areas to the north and east, fishing pressure is expected to likewise increase. Fishing is a popular activity among residents and domestic tourists. As such, any attempts to change fishing regulations will be highly political (Jones, Wood, et al. 2011). Snorkelling is the most popular tourist activity in the region, and coral damage caused by swimmers and divers is another impact; however, this is localised to popular snorkelling and diving areas and not considered to be a threat to overall reef health (Jones, Wood, et al. 2011). Fox predation poses a continuous and significant threat to sea turtle nests, and turtle populations are expected to fall if fox baiting is not maintained or expanded (Fulton, Gray, et al. 2011). Increased industrial sea traffic has the potential to increase whale and whale shark22 boat strikes, and to disturb humpback cows and calves

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22 Although boat strikes are not expected to have a significant impact on the overall whale shark population, because stricken sharks will most likely be younger animals that spend most of their time at the surface (those that are targeted by
whale-shark tours), a 5% drop in whale shark numbers due to boat strike will translate into a two-fold reduction in the likelihood that a whale shark tour operator will find a shark on the surface (Fulton, Gray, et al. 2011).
resting and fattening in Exmouth Gulf before their migration to Antarctica (Fulton, Gray, et al. 2011). Potential longer-range threats to the region’s ecology include increasing oil and gas development outside the marine park boundary, and climate change, which threatens the survival of the reef (via bleaching and acidification) and turtle nesting beaches (via rising sea levels) (Fulton, Gray, et al. 2011).

4.2.2 Community Profile

The following is a brief overview of Ningaloo’s community profile. For more detail and an excellent historical summary of the Ningaloo area, see Jones et al.’s chapter, Waltzing the Heritage Icons: ‘Swagmen’, ‘Squatters’ and ‘Troopers’ at North West Cape and Ningaloo Reef, in Geographies of Australian Heritages (Jones et al. 2007).

Aboriginal people have occupied the Northwest Cape for more than thirty thousand years as evidenced by the discovery of a shell-bead necklace in Cape Range dated at 32,000 years old (World Heritage Consultative Committee 2004). Aboriginal communities left the area around 1900, after pastoral stations began to establish in the region. Most of their descendants now live in Carnarvon and Onslow (Jones, Wood, et al. 2011). The region is part of the traditional territory of the Gnalli native title claimants, which includes the Baiyungu, Inggarda, Thalanji, Thudgarri and Malgana people. As such it should be recognised that the region is a ‘culture-scape’, not just as an ecological landscape from which indigenous worldviews are erased (Scherrer & Doohan 2011). Two Aboriginal corporations are based in the region, the Baiyungu Aboriginal Corporation out of Carnarvon, and the Northwest Cape Aboriginal Corporation out of Exmouth. In 1999, the Baiyungu Aboriginal Corporation gained ownership of Cardabai Station, north of Coral Bay (Jones, Wood, et al. 2011).

In 1876 pastoral stations began to establish in the area, and most of the region’s land is now under pastoral lease, including Ningaloo, Warroora, Cardabai, Gnaraloo, and Quobba stations. However, as marine waters and coastal areas have been taken up into conservation estate in recent years, tension between pastoralists and government agencies has been mounting (Jones et al. 2007). In 2015 all pastoralists in WA will have to apply to the Pastoral Lands Board to renew their leases. The Pastoral Lands Board has been in the process of identifying a million hectares of pastoral land that will be transferred from pastoral use to Aboriginal control or to conservation and recreation (Jones et al. 2007). For decades, the pastoral lessees occupying the Ningaloo Coast have augmented their farm incomes by raising tourism revenues from coastal camping, much of which has been promoted as ‘wilderness’ camping with minimal controls or facilities (although this is changing, as lessees develop more structured tourism nodes). These coastal areas are of high conservation and recreational value, and government proposals have been made to excise a 2km coastal strip from the all the station leases. Lessees have argued that their operations would no longer be viable should this take place (Jones et al. 2007). While the 2km excision appeared imminent under the previous Labor state government, this was no longer the case under subsequent Liberal Party rule.

The Ningaloo reef and the Cape Range karst systems are internationally recognized for their exceptional biodiversity and scenic values. In 1964, the Shire of Exmouth initiated the gazettal of Cape Range National Park on the northwest side of the North-West Cape Peninsula. The park now encompasses 50,581 ha of the Cape’s coastal plain and limestone ranges, and has an important role in protecting the Cape’s renowned karst system, with its unique and ancient subterranean stygofauna (World Heritage Consultative Committee 2004). In 1987, Ningaloo Marine Park was established. The park was then 270 km long, and included state waters, most of the reef, and an adjoining 40m wide coastal strip. In 2004 the park was extended to include the Ningaloo reef’s entire 300km length, from the tip of the Cape to Red Bluff. Both parks are administered by the Western Australian Department of Environment and Conservation (DEC). Subsequent zoning of no-fishing sanctuary zones within the marine park has created considerable tension between DEC and recreational fishing interests, including local community members, local and state recreational fishing groups, wilderness campers, and the pastoralists who host large numbers of recreational fishers.
In 2004, the State government recommended Ningaloo be nominated for World Heritage listing on the basis of its outstanding natural values. Its nomination was accepted in 2011, amid much controversy and local resistance, particularly by pastoralists, wilderness campers, and community members and businesses in Exmouth. Those resisting the nomination were primarily concerned that it would pre-empt and provide the justification for the excision of a 2km strip from pastoral lands and impose restrictions on local industries and fishing.

The study area falls within the boundaries of two shires: the Shire of Exmouth and the Shire of Carnarvon. The region is sparsely populated. According to statistics for 2007-08 (WA Local Government Directory), the Shire of Carnarvon, which is 902km from Perth, has a population of 9,046, most of whom reside within the towns of Carnarvon (pop. 5,682) and Coral Bay (pop. 247). The main industries within the Shire of Carnarvon are horticulture, livestock, mining and tourism, with the majority tourism focused in Coral Bay, a premier tourism destination in WA, and in station-based fishing and surfing destinations along the coast (ACIL Tasman 2009). The Shire of Exmouth lies 1270km from Perth, with a population of 2,245, most of whom reside in the town of Exmouth. Exmouth originated in the 1960s to service a now-defunct American naval base. Today, the primary industries in the Shire of Exmouth are tourism, commercial fishing and oil and gas servicing, with tourism largely focused on Cape Range National Park, station-based fishing and camping along the coast, and the Ningaloo Marine Park.

Because of the region’s exceptional scenery and natural values, Ningaloo is one of Western Australia’s premier tourist destinations (Western Australia Planning Commission 2004), attracting thousands of national and international visitors every year. In 2004 the area saw a peak of 208,000 visitors; in 2008 visitor numbers were 176,000 (Jones, Wood, et al. 2011). Nature-based tourism is one of the region’s main economic drivers, and the primary source of income in Coral Bay and Exmouth. Tourism is focused on marine activities in the cooler winter months, including snorkelling, scuba diving, surfing, visiting beaches and swimming with whale sharks, dolphins and manta rays (Jones, Wood, et al. 2011). A significant proportion of the area’s domestic visitors consist of ‘grey nomads’, retired Australian campers. Many grey nomads prefer wilderness camping on the pastoral stations, and make extended yearly trips to the region (Jones, Wood, et al. 2011).

The Ningaloo region is also under mounting influence by heavy industry (mining and oil and gas) in neighbouring regions to the north and the east, and there is an increasing number of off-shore oil and gas facilities locating within 20-50km of the Ningaloo Marine Park (Fulton, Gray, et al. 2011). Whereas in recent years tourism has outstripped agriculture in terms of generating revenue and employment, tourism now appears to have somewhat flatlined, and there is increasing interest in hosting industrial support activities in the region.

Demographic changes resulting from the growing natural gas industry have been attributed to recent cost-of-living increases and accommodation shortages in the Exmouth area, and to increased fishing pressure in the region (Dzidic et al. 2011). Modelling work completed by Fulton et al. (2011) indicates that Ningaloo’s economy is vulnerable to stagnation due to its ageing resident population. Attempts to offset this effect with economic growth will be constrained by labour and housing shortages, and at the cost of creating additional pressures on housing, utilities and waste management. Increased industrial and/or resort development will likely have the twin effect of greater growth, population and services in the region, but while also increasing housing costs and crowding. This may contribute to the lowering the value of the tourism experience, leading to lower per-night spend by tourists (Fulton, Gray, et al. 2011). Under existing regulations, higher economic growth will also increase pressure on regional ecosystems, particularly fish stocks. Modelling indicates that changes to regulations (e.g. modified bag limits for fish) and caps on such things as access (e.g. roads and boat ramps), visitor numbers, and local populations would help offset some impacts of economic growth on the region’s environment and resident’s lifestyle (Fulton, Gray, et al. 2011).
4.2.3 Planning Context

In 2004, the Western Australian Planning Commission, under a then newly elected New Labor government, set up the Ningaloo Sustainable Development Office (NSDO), after the high profile dispute around the Maud’s Landing resort proposal near Coral Bay. The function of this regionally-based office of the Western Australian Department of Planning was to prepare and oversee a statutory scheme for the Ningaloo Coast: the Ningaloo Coast Regional Strategy Carnarvon to Exmouth (henceforth referred to as the Coastal Strategy) (Western Australia Planning Commission 2004). The Coastal Strategy is a 30-year strategic planning framework meant to guide land-use planning, tourism, environmental management and economic and urban development in the region.

The vision of the Strategy is to ensure that development on Ningaloo’s sensitive coastal strip is managed for low impact tourism and preservation of ecosystems. As such, the Strategy identifies a number of nodes along Ningaloo coastal strip for focusing more intensive tourism development, and outlines environmental guidelines for sustainable tourism. The intended role of the NSDO was to oversee the roll-out of the Coastal Strategy; however, in 2009, the NSDO was closed when a new Liberal Government came into power in the State.

In 2009, the Western Australia Planning Commission (WAPC) established regional planning committees for each region in the state. The Gascoyne Regional Planning Committee (GRPC) is now the successor of the NSDO, and oversees regional planning in the wider Gascoyne region, of which Ningaloo is a part. Unlike the NSDO, it appears unlikely that the GRPC will have a staff presence in the Ningaloo area (Jones, Wood, et al. 2011).

The Ningaloo region is subject to a number of other largely uncoordinated planning processes. For example, the Cape Range National Park Management Plan (Department of Environment and Conservation 2010), and the Ningaloo Marine Park Management Plan (Department of Conservation and Land Management 2005) are administered by the DEC, and guide management activity in the parks. The Shire of Exmouth Structure Plan and Local Tourism Planning Strategy are administered by the Shire, and will guide town growth and a marina development (Jones, Wood, et al. 2011). Jones, Wood, et al. (2011) note that the lack of planning coordination between these agencies “raises concerns about the cumulative impacts of the plans, which are focused on drawing more people to the region, or on managing the impacts of human activity without considering the potential size of future numbers” (p.62).

The Gascoyne Development Commission (GDC) is a regionally-based state agency responsible for facilitating social and economic development in the region. The commission’s activities include broadening the region’s economic base, identifying service and infrastructure needs, job creation and training, providing information and advice, and ensuring equitable access to government services in the region. The commission’s main office is in Carnarvon, and it also has a one-person satellite office in Exmouth. Its board consists of representatives from local government and the community, as well as ministerial appointees. While the GDC does not have a direct planning role in the region, it does influence infrastructure and development decisions and funding.

There are number of community and conservation groups which have an interest in or whose work influences resource management in the region. Prominent groups in the Exmouth area include the Northwest Cape Conservation Group, the Recreational Fishing Advisory Committee, the Exmouth Chamber of Commerce and the Centre for Whale Research.

4.2.4 Regional Tensions

The Ningaloo region suffers an uneasy tension between conservation agencies, wilderness campers and pastoralists, which has erupted into hotly-debated land use conflicts over resort developments, marine sanctuaries, and World Heritage nomination (Jones, Wood, et al. 2011). Jones et al. (2011) cite two television documentaries and other research (Jones et al. 2007) that highlight these conflicts. According to Ingram (2008), although local communities have benefited from the tourism generated through the establishment of protected areas, management policies and prescriptions designed to mitigate impacts of high levels of visitation have had an alienating impact
Community perception of park management has been negatively impacted by recreational fishing constraints imposed during a 2004 planning process for Ningaloo Marine Park. The planning process itself also led to feelings of distrust and disrespect towards DEC and its management programs (Ingram 2008). Ingram (2008) notes that community feeling that DEC has continued to conduct insufficient consultation and communication has contributed to these negative perceptions. Such negative perceptions and reactions (e.g. local opposition to World Heritage listing) reflect resident anxieties that Perth-based agencies are making decisions about the region’s future with little consideration for their own concerns and interests (Jones, Wood, et al. 2011). Jones et al. (2007) observe that the players in this regional conflict resonate strikingly with key figures in Australia’s historical iconography. They evoke Waltzing Matilda as a metaphor:

…where, in a waterside, outback setting, a contestation occurs between a consumption-oriented swagman (a camper making unauthorized use of the local resources), a production-oriented squatter (a pastoralist) and the protection-oriented troopers (the local regulatory authorities). In the ballad, the differences between the protagonists are not reconciled and the ending is tragic. (p.82)

Certainly, the division between the Shires, DEC, pastoralists, and the local community has had implications, including “involuntary production of a community psychology that fails to embrace community stewardship of an enormously valuable natural asset” (Ingram 2008, p.211). This division continues to rend the community fabric and disrupt attempts to foster joint stewardship of local resources. However, in the latter stages of this project, changes in the heads of most of the key government agencies operating out of Exmouth helped lead to a ‘warming’ of relations between these groups, and some optimistic signs of future cooperation that were absent at the beginning of the study.

These findings are supported by research by Dzidic et al. (2011), which concluded that a major concern among the region’s communities was a sense of powerlessness in relation to regional planning. They found that industrial (fishing, tourism etc.) and natural assets were perceived as being locally owned, and that locals held a degree of resentment toward governmental and scientific control of these resources. Indeed, Dzidic et al. (2011) noted that the perceived “seagull” approach to science in the region, whereby “scientists and research ‘swoop’ into communities, scavenge for information and data they require and then leave again” (p.22), was heavily criticized by stakeholders across the region. The authors also found that many community members were acutely aware of the power differential between themselves and bureaucrats and scientists working in the region. This is exemplified by the sociogram drawn by one of their research participants, as shown in Figure 4.2. Their research also showed that participants interacted with just under half of the organisations operating in the Ningaloo region, and that only 17% of these interactions were regarded as helpful. The organisations that were not found to be helpful by any of these participants were largely research organisations and universities. CSIRO was the organisation that had the fewest overall interactions (both positive and negative).

4.2.5 Ningaloo Research Program (NRP)

As described in Chapter 1, the Ningaloo Research program (NRP) is a large $36 million collaborative research program that, between 2006 and 2011, brought together more than 100 scientists from the Ningaloo Collaboration Cluster23 (NCC) and the Western Australian Marine Science Institute (WAMSI) to study the processes of human interaction with Ningaloo Reef. The research program was based on information needs identified in the Management Plan for the Ningaloo Marine Park and the Muiron Islands Marine Management Area 2005-2015 (Department of Conservation

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23 The Ningaloo Collaboration Cluster is a major research project that commenced in the region in 2007, involving researchers from the CSIRO, Sustainable Tourism Cooperative Research Centre and a range of Australian Universities including Curtin University of Technology, Murdoch University, University of Western Australia, Australian National University and the University of Queensland.
and Land Management 2005) and included research on: geomorphology, bathymetry, marine biodiversity and abundance, marine habitats, sanctuary zone efficacy, human use of coastal areas, socio-economics of tourism, and management strategy evaluation. The aim of the NRP was to provide managers with knowledge and tools for making well-informed decisions about the Ningaloo Marine Park and the region.

The NRP’s activities were coordinated through the combined efforts of two management committees populated by NCC and WAMSI representatives, including modelling research leaders Dr. Tod Jones and Dr. Beth Fulton, as well as communications officers (Longeran et al. 2011). These committees will forthwith be collectively referred to as the research program’s management coordination committee. The purpose of the management coordination committee was to facilitate collaboration between research projects, and to enhance the transfer of research findings to different stakeholder groups.

Figure 4.2. Participant sociogram from research done in the Ningaloo region by Dzidic et al. (2011, p.24).

4.2.5.1 Modelling Projects

Two projects within the NCC involved developing computer models that sought to integrate data collected across the Ningaloo region: the Ningaloo Destination Modelling project (NDM) and the In Vitro model. The intended purpose of these models is to help planners to explore different development scenarios and management options, by evaluating their potential economic, environmental and social impacts, identifying trade-offs between competing uses, and looking for ways of minimising negative impacts and maximising the benefits of different decisions.

The Ningaloo Destination Model was developed by Curtin University of Technology, under the guidance of Dr Tod Jones (Jones, Wood, et al. 2011), to help plan for future tourism development. The model looks at a broad range of impacts generated by different tourism scenarios in the region (e.g. numbers of tourists generated by a tourism development, where they go and what they do, money they spend, employment they create, the amount of water and electricity they use, waste they create, crowding, impacts on fish, corals, turtles, etc.). This model works at a relatively broad scale and is useful for assessing the impacts of tourism planning decisions over a number of years. A considerable amount of formal and informal stakeholder engagement was involved in the model’s development, as detailed in Jones et al. (2011).
Chapter 4

In Vitro is a regional management model developed by the CSIRO’s Marine and Atmospheric Research Division, under the guidance of Dr Beth Fulton (Fulton, Gray, et al. 2011). The model is part of a Management Strategy Evaluation (MSE) project24 where project researchers integrated the research and data collected for the Ningaloo region, to develop a ‘whole of system’ model incorporating the region’s physical environment, ecological components, human industries and communities. The model can be used to explore the effects of alternative management options for all sectors (tourism, industrial, environmental, pastoral etc.) in the Ningaloo-Exmouth region. Its intended purpose is to facilitate decision-making and sustainable adaptive management, and avoid clashes between interest groups. Project researchers engaged with regional and Perth-based stakeholders as part of the model development, as well as with other NRP scientists. The details of this engagement are addressed by Fulton, Jones, et al. (2013).

In 2010, as their projects neared completion, the modelling researchers for these two projects joined forces to begin fine-tuning and promoting their models among stakeholders in the Ningaloo region. Because the In Vitro model was not ready for live use at this time, Dr Fulton constructed a stand-in ecological model using Ecopath and Ecosim25. This model was calibrated and one-way coupled with the Ningaloo Tourism Destination Model in order to simulate the ecological impacts of different tourism planning decisions.

4.2.5.2 Research Clients

The NCC also devised a small ‘Client Outreach’ project (Dzidic et al. 2011; Syme et al. 2012) to support the NCC’s efforts to see that its research and modelling tools would have impact. This project involved engaging stakeholders to devise sociograms as a means of exploring group roles and networks within the milieu of stakeholders (including scientists) operating in the Ningaloo region. The purpose of this work was to identify potential end-users (i.e. clients) for the NRP’s research. Dzidic et al. (2011) note that the aim of the NRP (to ensure sustainability of Ningaloo reef) was partly predicated on the assumption that there was social capacity to implement the research findings. An Egonet diagram (Figure 4.3) from their research depicts a snapshot of stakeholder networks in the region. Their work showed that while there were strong links between different researchers and research groups, the research community as a whole was relatively isolated from other stakeholder groups. Their work also showed that while the community helps research groups do their work in the region, this is not reciprocated, and the information flow tends to be one way (Syme et al. 2012).

A target client for the NCC research and modelling projects was the NSDO. The NSDO was the most likely custodian for the models due to their oversight of land use planning along the coastline between Carnarvon and Exmouth (a critical process in controlling tourism development), and their coordination of regional development (Jones, Wood, et al. 2011). The NSDO had the capacity to promote model use across organisations and feed research results into planning processes; initial discussions indicated that they would be willing to take custody of the model (Jones, Wood, et al. 2011). However, as mentioned above, after the change in government in 2008, funding for the NSDO was discontinued and its staff left the Department of Planning. This meant that clear

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24 Management Strategy Evaluation (MSE) is a framework for helping management agencies and stakeholders make informed decisions. Firstly, MSE helps people deal with system complexity by using computers to model the dynamic interactions within and between the natural and human systems under examination. Secondly, MSE uses computer models to simulate the different steps in adaptive management, and to assess performance and trade-offs of different management strategies within these complex socio-ecological-economic systems. In this capacity, MSE projects allow the desirability of different management strategies to be assessed in the ‘cyber’ world before trialling them in the ‘real’ world. Thirdly, engaging different stakeholders in designing the models, formulating problems and assessing different strategies can ultimately lead to on-the-ground improvements in collective problem-solving and decision-making (Fulton, Gray, et al. 2011).

25 In addition to the highly sophisticated In Vitro model, Beth Fulton developed a Ningaloo Ecopath with Ecosim Model, which was used for the stakeholder engagement process, as the In Vitro model was not ready for live use at this time. This model simulates the ecological impacts of different management scenarios, as well as the implications for different activities (such as catch rates for recreational or commercial fishing).
delivery of modelling tools to a local champion, who would use the model and communicate its results, had become problematic\(^2\) (Jones, Wood, et al. 2011).

The NCC modelling researchers responded to the NSDO closure by redoubling efforts to cultivate relationships with key staff members in different organisations who could champion the research and models within their organisations, and potentially beyond to other groups (Jones, Wood, et al. 2011). However, staff turnover in locally-based organisations was a problem; when agency staff turned-over, researchers would have to start relationship-building again. Staff turnover in Exmouth was very high: only one out of six original staff in the Shire’s senior management team remained through the three-year life of the NDM project. Because these individuals were originally conceived as the key people for promoting model uptake in the region, their departure was a major impediment to information flow (Jones, Wood, et al. 2011).

Figure 4.3. Ningaloo network with group clusters for research and advisory (red), governance and service (blue), community (green) and peripheral (grey) node. The abbreviations are explained in Appendix 5 (source: Dzidik et al. 2011; Department of Planning WA).

### 4.3 Project Conception

I commenced work on this PhD project as part of the Ningaloo Collaboration Cluster in September 2008. The original scope of the project was very broad, that being the social-ecology of Ningaloo. By December 2008, I had narrowed the project scope and developed a proposal for a study that would use an action research approach involving co-learning and collaborative planning to explore institutional capacity to respond and adapt to feedback from research and modelling work being done in the Ningaloo region of Western Australia. Upon conducting additional literature review, I became familiar with Patricia Shaw’s work on using conversation to induce change and adaptation in organisations (Shaw 2002). This led to a shift in the proposed methodology, whereby I decided to take on the role of a “knowledge broker” (as per the literature given in Chapter 3) embedded in the Ningaloo region, to see if knowledge transfer could be

\(^2\)Jones et al. (2011) note that this is an on-going issue for research bodies. Although there is a demand for tools that support adaptive resource management, there is often little scope within busy management agencies and businesses to adopt modelling tools (some of which require specialist skills to operate). In addition, modern funding arrangements make maintenance of such tools within research bodies problematic, with staff moving on to new questions in new locations once they finish a research project (Jones, Wood, et al. 2011).
enhanced by increasing connections, via face-to-face conversation, between researchers and managers in the Ningaloo system. The relationship between my project and other elements in the Ningaloo research program is illustrated in Figure 4.4.

![Diagram](image)

**Figure 4.4.** Relationships between different components of the Ningaloo Research Program. This action research study is indicated by the red highlighted box on the lower left. The red dashed arrows indicate the entities with whom I collaborated on this project.

At the end of May 2009, I presented my revised proposal and results from my literature review (a summary of success and failure factors identified in the literature in relation to the formation of adaptive institutions) at the Ningaloo Symposium, an Exmouth-based event coordinated by WAMSI and the NCC to showcase research progress in Ningaloo. The audience was primarily researchers involved in the Ningaloo research program, although there were also some locals in attendance. The presentation appeared to create a bit of a ‘buzz’; a fellow researcher told me that she had heard a few people using the same ‘language’ as I had used in my presentation, and a number of other researchers approached me afterwards saying things like “we need to have a ‘conversation’”, or “I’m sick of having conversations”.

The primary outcome of my attendance at the Ningaloo Symposium was the ad hoc formation a steering committee for my research project, at the behest of Professor David Wood, who was heading up the socio-economics component of the NCC, and who had been serving as the chair of the NSDO. He invited a group of symposium attendees to dinner on the final night of the symposium to discuss my research project. The group included a number of senior researchers and the Shire President for Exmouth. The end result was a number of these individuals agreed to sit on a steering committee for my research project. The interest in my project can largely be attributed to NSDO closing down at this time. The NSDO was intended as the major client for the research program’s results and models, and their dissolution was a matter of considerable concern. My project was seen as a potential vehicle for finding an alternative means of achieving research uptake.
in the region. Professor Wood also recommended that I sit on the research program’s monthly management coordination meetings.

Although the steering committee largely fell away after a few months, it served to establish an ongoing relationship between myself and the Shire President, which remained in place for the length of the research project. I also established a strong relationship with Dr. Tod Jones, who took over the socio-economic component of the NCC’s research program after Professor Wood moved into a different role. Dr. Jones introduced me to various stakeholders in the region, kept me up to date on relevant planning processes that were underway, and became a primary collaborator in my project, together with Dr. Beth Fulton. On Professor Wood’s behest, I also became a regular participant in the NRP’s monthly management committee meetings.

In June 2009, I met with Dr. Jones to discuss planning processes underway in the region, my methodology, and key stakeholder groups in the region. The main outcome of this meeting was Dr. Jones providing me with a contact list of the key stakeholders that he had assembled during the course of research he and Professor Wood had been conducting in the region over the last few years.

In June 2009, I moved to Exmouth to start the field component of my project. This involved living and immersing myself in the community for the next year and a half. As such, I began introducing myself and my project to local stakeholders and arranging interviews.

4.4 Plan: Initial Assessment of Stakeholder Perspectives

As outlined in Chapter 3, Lomas (2007) describes knowledge brokering as any activity which links and facilitates interactions between researchers and decision-makers, such that they better understand and influence each other, and partner and promote research in decision-making.

Between August 2009 and August 2010, I conducted over 30 interviews with researchers, government staff, business owners, tourism operators, pastoralists, Aboriginal corporation members, conservation group members and community members, to explore their ideas around barriers and opportunities for translating NRP’s research into practice. I compiled the results of those interviews, organised by theme, into a document, then circulated copies to all those I had interviewed and to the NRP’s management coordination committee. As a knowledge broker, this was my first major step: surfacing the goals, ideas, needs, concerns and cultures of researchers and regional stakeholders, and sharing this information in an effort to build mutual understanding.

The complete results from my interviews are presented in Appendix 6. An overview of these results and a discussion of their relation to the literature reviewed in Chapter 3 are outlined below.

4.4.1 Barriers to Knowledge Transfer

4.4.1.1 Internal barriers

Barriers to knowledge transfer can be divided into those internal to the research process and those external. A number of barriers identified as being internal to the research process were cited in the stakeholder interviews. For example, many local stakeholders were upset by what they felt was a lack of local inclusion and feedback in the research process. Some also felt that the Ningaloo Symposium was not very effective in reaching local audiences. Other issues included: scientists having insufficient regard for local knowledge and concerns, difficulties accessing research, delays in research being released, bureaucracy impeding local participation in research, and difficulties maintaining long-term relationships between researchers and the region, particularly as researchers move on to new projects.

27 As noted in Chapter 1, in this thesis the term ‘stakeholder’ will be based on Freeman’s (1984) definition, and will refer to any group or individual who can affect, or is affected by, the achievement of the aim of the NRP. As such, researchers are also considered stakeholders in this study.
In addition, many stakeholders felt that strategies for putting the research into practice were wanting. It was also noted that some researchers are unconcerned with the management implications of their work, and that research often lacks relevance to operational and pragmatic concerns. Some stakeholders noted that many scientists are not good communicators and often feel that communication is not part of their role. It was noted that scientists have their own ‘language’, and sometimes have low regard for non-scientists. Idealism among scientists, especially younger ones, was also identified as a concern. Others noted occasions when scientists did not acknowledge the help or support of others or broke rules and regulations in the marine park.

The scale of the research was raised as another barrier, particularly the lack of site-specific information for planning and managing visitor activities and park infrastructure. The error and uncertainty associated with research being done in complex systems was also a concern. Absence of a long-term custodian for the models and lack of uptake by agencies were identified as major issues. Concerns were also raised about whether the models would be relevant to local issues and made available for local use. Some noted that the models might be too complex and that only very simple models would actually be used. In contrast, others were concerned the models would not reflect real-world complexity and things like “red tape” and human feelings. It was also noted that some people would have unrealistic expectations of the models, expecting the models to predict the future and make decisions for them.

Other internal barriers to research uptake were cited as: variable research quality, ethical issues around sharing data, and having too many researchers in the region with too much overlap and too little integration between their topics.

These barriers are consistent with those identified in the literature reviewed in Chapter 3 and summarised in Table 3.1. They include almost all the cultural barriers cited by managers in Roux et al.’s (2006) review of knowledge transfer (Chapter 3, Section 3.3). However, the one issue that appeared to be of greatest concern to Ningaloo stakeholders—that being lack of local inclusion and feedback—was not mentioned in Roux et al.’s review of barriers. This concern does, however, resonate with McNie’s (2007, Chapter 3, Section 3.3) assertions that scientists often exclude local knowledge, and lack the skills, ability and/or willingness to engage in participatory processes, especially over the long term. They also reflect her suggestion that decision-makers often find the uncertainty and scale of scientific work problematic.

Internal barriers that were noted by Ningaloo stakeholders but which were not identified in the literature reviewed in Chapter 3 included: the variability of research quality, the ethics of data sharing, and having too many researchers with insufficient integration between their topics. Concerns in relation to modelling were outside the scope of the literature review.

4.4.1.2 External Barriers

A number of knowledge transfer barriers external to the research process were also identified. High staff turnover in regional government offices was a particular concern, as was agency staff lacking the time and resources to find and use relevant research. In particular it was noted that high staff turnover would confound attempts to provide agencies with model training. Loss of the NSDO was cited as a major issue, as the NDSO was to be the major recipient of the research findings and modelling tools. Added to this was uncertainty over who would be responsible for managing the coastal strip. Poor agency reputation and anti-government sentiment in the region were cited as issues, as were modes of communication used by government, and the unwillingness of agencies to trust research carried out by the private sector.

A number of stakeholders noted that the Exmouth community is very apathetic, in part because it has a large transient population. It was also noted that many community members do not believe in science and do not like change that might be precipitated by research findings. The absence of a cohesive vision for how the region should be developed was cited as a concern. It was also noted
that visioning exercises have no value unless they have concrete outcomes, and that previous Shire-led visioning exercises undertaken in the region have not had follow-through.

Silo behaviour and mentality, and resultant lack of integration between groups and agencies working in the region were cited as major barriers. Some stakeholders were concerned about the divide between researchers and managers, and between public and private interests. A number of stakeholders felt that the research findings would be over-ridden by political concerns during decision-making. It was also suggested that research uptake by the region would be stymied by the absence of an ecological crisis and/or a lack of political, social and economic imperative.

Only three of these external barriers—agencies lacking time and resources to find and use research, community members not believing in/appreciating science, and research concerns being overridden by political concerns—were reflected in reviews covered in Chapter 3. For comparison purposes, Table 4.1 summarises the internal and external knowledge transfer barriers identified by Ningaloo stakeholders.

Table 4.1. Summary of knowledge transfer barriers identified by Ningaloo stakeholders during interviews at the study outset.

<table>
<thead>
<tr>
<th>Internal (research-side) knowledge transfer barriers</th>
<th>External (management/community-side) knowledge transfer barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lack of local inclusion and feedback in research process</td>
<td>• High staff turnover in regional agencies</td>
</tr>
<tr>
<td>• Research presentations not reaching local audiences</td>
<td>• Loss of NSDO as client and host for models</td>
</tr>
<tr>
<td>• Insufficient regard for local knowledge and concerns</td>
<td>• Uncertainty about who will manage coastal strip</td>
</tr>
<tr>
<td>• Lack of concern for management implications of research</td>
<td>• Poor agency reputation</td>
</tr>
<tr>
<td>• Lack of research relevance to operational/pragmatic concerns</td>
<td>• Anti-government sentiment in local community</td>
</tr>
<tr>
<td>• Scale of research not useful site specific planning</td>
<td>• Agency communication is ineffective</td>
</tr>
<tr>
<td>• Error and uncertainty in research results</td>
<td>• Unwillingness of agencies to trust research carried out by private sector</td>
</tr>
<tr>
<td>• Some researchers are poor or unwilling communicators</td>
<td>• Apathy in local community</td>
</tr>
<tr>
<td>• Scientists have their own ‘language’</td>
<td>• Highly transient population</td>
</tr>
<tr>
<td>• Assistance of locals not acknowledged</td>
<td>• Community members do not believe in science</td>
</tr>
<tr>
<td>• Breaking rules and regulations during research activities</td>
<td>• Absence of a cohesive vision for the region</td>
</tr>
<tr>
<td>• Lacking strategies for putting research into practice</td>
<td>• Silos and lack of integration between regional agencies and groups</td>
</tr>
<tr>
<td>• Research results are difficult to access</td>
<td>• Political concerns over-ride research during decision-making</td>
</tr>
<tr>
<td>• Delays in research being released</td>
<td>• Lack of crisis or imperative to use research</td>
</tr>
<tr>
<td>• Ethical issues around data sharing</td>
<td>• Bureaucracy impedes local participation in research</td>
</tr>
<tr>
<td>• Too many researchers with overlapping topics</td>
<td>• Difficulties maintaining long term research relationships with the region</td>
</tr>
<tr>
<td>• Bureaucracy impedes local participation in research</td>
<td>• No long term custodian identified for models</td>
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<tr>
<td>• Models not able to reflect real world complexity/issues</td>
<td>• Too many researchers with overlapping topics</td>
</tr>
</tbody>
</table>
4.4.2 Opportunities for Research Uptake

4.4.2.1 Using the Research

A number of interviewees suggested that the research and modelling could be used to help manage tourism and visitors, and to inform the decisions of politicians. Many felt it could be used for managing the parks, determining park carrying capacity, and revising park management plans. Others suggested using the research for assessing the effectiveness of the sanctuary zones, planning for facilities and services, managing fisheries and the reef, and developing sustainability indicators.

It was also recommended that the research and modelling should be used to help manage the coastal strip in relation to accommodating visitor preferences, assessing campsite locations, and planning for facilities and infrastructure. Using it to predict infrastructure and service demand in the towns and the region, particularly with respect to road works, waste and water, was mentioned.

Assessing the impacts of proposed developments and negotiating trade-offs between interest groups were cited as uses for the research and modelling. In particular, stakeholders noted the modelling could be used to assess the advantages and disadvantages of new boat ramps, oil and gas projects, Straits Salt, and the marina expansion. Informing policy and planning was another widely cited use for the research and models. It was noted that the models could help with collaborative planning and consulting stakeholder groups. Some stakeholders advised that the models could be used to review the Coastal Strategy and the Exmouth Structure Plan. Other suggested uses were: assisting the new Gascoyne Region Planning Committee, supporting Australia’s National Landscapes branding for Ningaloo, conducting regional planning and visioning exercises, and assessing the impacts of World Heritage listing.

Stakeholders recognised how research could be used to educate the public and foster responsible behaviour. Some suggested the research could be used by tourism operators to inform their clients. It was recommended that the models be used as learning tools to allow people to gain a better understanding of how complex systems such as Ningaloo work. In addition, a number of people felt the research, especially the tourism destination model and the visitor statistics, would provide useful information about tourism and the market.

It was also suggested that the research be used to bring together different stakeholders in the region, to share information and issues, build understanding and get people working together. Additionally, there was hope that the research would address cultural concerns along the coast, particularly in relation to its cultural significance to Aboriginal people and ensuring people respect and take care of the coastline. Others saw that the research and models could be used to support funding for things like future research and local government services.

Clearly, given the breadth of suggested applications, the interviewed stakeholders believed that the NRP’s research could be useful information for decision-making, as per McNie’s (2007) notion of reconciling the supply of scientific information with users’ demands (Chapter 3). This is due in part because the research program was based on information needs identified in the Management Plan for the Ningaloo Marine Park and the Muiron Islands Marine Management Area 2005-2015, thereby ensuring it met DEC’s research requirements for the area (a ‘pull strategy’ on the part of DEC, as per Roux et al., 2006, Chapter 3). It is likely also due in part because of the amount of formal and informal stakeholder engagement that had been involved in developing the Ningaloo Destination Model and the InVitro Model. Both of these items relate to the first strategy outlined by McNie (2007, Chapter 3) in relation to generating useful information for decision-making—that being to reach out and identify the needs of decision-makers. However, the other strategies outlined by McNie—such as including stakeholders in decision-making, improving relationships between scientists and managers through social learning and co-production of research, and developing a framework for linking scientists and decision-makers—had not been applied by NRP scientists. Nor had Roux et al.’s (2006) ‘push strategies’ of involving end-users in the knowledge creation process (although this was done to some extent during model creation) and improving scientists’ credibility (Chapter 3).
4.4.2.2 Promoting Research Uptake

Stakeholders also made numerous suggestions for promoting research uptake in the region. The importance of sustaining ongoing relationships between researchers and the region was stressed, as was having a “leave something behind strategy” to build capacity and leave a permanent presence. Others cited the importance of WAMSI’s knowledge transfer framework. Engaging a coordinator to help get the research results to the community was suggested. Some felt that creating a new regional body, like a Ningaloo Trust, would help research uptake, whereas others felt that improving existing government structures would be a better option. Other suggestions included: partnering with landholders and tourism operators to get the research results out to the public, hosting a forum to discuss potential management applications of the research, posting follow-up research opportunities on a website, and integrating data with that of other agencies. All of these suggestions are consistent with McNie’s (2007) strategies for generating useful information for decision-making, as outlined in Chapter 3, Section 3.4.1. The suggestion of employing a coordinator to bridge the research-management interface is consistent with ideas around knowledge brokering (Chapter 3, Section 3.7.2), and the idea of a regional Ningaloo Trust is consistent with ideas around boundary organisations, as per Cash (2000) and Cash et al. (2003) (Chapter 3, Section 3.7.1).

Making the models accessible to everyone was cited as important, as was simplifying the models and developing visualisations of the model results. Several stakeholders stated that the models should be housed in the region; suggested homes included the GDC, the Gascoyne Regional Planning Committee, the Shires and the proposed Ningaloo Research Centre. Hiring a regional person to support and promote the models was recommended, as was collecting questions from stakeholders, running requested scenarios, training people and agencies to use the models, conducting demonstrations of the model around the region, evaluating and updating the models over time, and building trust and interest in the model outputs. It was also suggested that the models address ‘red-tape’ and triple-bottom line concerns.

Identifying key stakeholders in Perth and the region and devising a plan for engagement were recommended. Suggested target groups included: politicians and cabinet, government agencies and regulators, indigenous groups, local residents, pastoralists, tourism operators, businesses, recreational and commercial fishers, accommodation providers, schools, industry, consultants, and the scientific community. Suggestions were also made to engage community groups: the Cape Conservation Group, Exmouth Game Fishing Club, Chamber of Commerce, Ningaloo Research Centre working group, Coral Coast Parks Advisory Committee, Cape Board Riders, visitor centre committees, Coral Bay Progress Association, and the Ningaloo Turtle Program.

Numerous stakeholders emphasised the importance of getting the research results out and making them available to everyone. Some suggested developing a communications plan and partnering with other agencies such as DEC and the GDC to roll it out. The importance of communicating rather than just putting out information was stressed. Other suggestions included training scientists to become better communicators and using mediators to help scientists communicate. The importance of having a ‘no surprises’ policy for government and locals was also noted.

Stakeholders made recommendations on how to format the research results. These included: using formats that meet stakeholder needs, using simple language, organising results by theme or subject, and focusing on recommendations (rather than methodologies). It was suggested that the research be assembled to tell a story, and that research interpretation focus on ‘what’s in it for them’, highlighting the benefits for business, government, lifestyle, etc.

Numerous types of communication channels were recommended by stakeholders. The importance of face-to-face contact was stressed, via presentations, forums and one-on-one meetings, particularly for Aboriginal groups. Other suggested channels included: research summaries and fact sheets, research reports, government briefings, a website, links to high traffic websites, coffee table books, displays, magazine articles, media releases, flyers and mail outs, contact database, newsletters (hard copy and electronic), maps, Google Earth, schools, libraries and community centres. The
proposed Ningaloo Research Centre was also repeatedly identified as a venue for showcasing the research.

Stakeholder recommendations on how to format or channel scientific information relate to one of the ‘push strategies’ outlined by Roux et al. (2006, Chapter 3), whereby science is packaged in accordance to the preferences of users. Suggestions around using the proposed Ningaloo Research Centre as a venue to host and showcase research is consistent with the concept of boundary organisations, as outlined by Cash (2000) and Cash et al. (2003) (Chapter 3).

4.4.2.3 Designing research for better uptake

A number of recommendations were made for designing research and research programs for better uptake. Suggestions for the research planning and design stage included: making communication proposals a required component of grant applications, spending more time scoping research projects, using an interdisciplinary approach to project design, taking care to relate research to management, and planning for a post-research presence in the study area.

Interdisciplinary collaboration and community engagement were identified as key ingredients for research uptake. Specific suggestions included: employing a coordinator to facilitate the research-management interface, engaging locals in the research process, involving stakeholders in model development, and being prepared to address conflict.

Having an innovative management committee made up of diverse, accomplished individuals was identified as an important success factor. Some stakeholders recommended changing research culture so it is more focused on having real-life impact, via greater collaboration, risk taking and experimentation. Including communication and knowledge transfer in research performance standards was recommended. In addition, it was suggested that researchers be required to consult local agencies when preparing licence applications, and to report their research findings to these agencies as a licence condition. Better sharing of information on research licences was recommended.

These suggestions were similar to those noted in the literature review in Chapter 3, particularly in relation to changing performance measures and research culture to be more focused on knowledge transfer. For example, McNie (2007) notes that academic performance is based on publications rather than producing information relevant to decision-making (Chapter 3, Section 3.3). In addition, stakeholders’ suggestions for promoting interdisciplinary collaboration and stakeholder engagement are consistent with the conceptual framework outlined in Chapter 3. A summary of knowledge transfer opportunities identified by Ningaloo stakeholders, in terms of research applications, promoting uptake, and research design, is outlined in Table 4.2.

4.4.3 Next Steps

These interview results served as the ‘plan’ stage of my project’s action research cycle, and informed my next steps, as per the knowledge brokering strategies outlined in Chapter 3, Table 3.4. Specifically, they helped me identify: potential research applications, which local groups and individuals would benefit from speaking to which researchers, who needed to be engaged, and appropriate forms of communication for different groups. The results also helped me identify the specific knowledge transfer barriers that would likely need to be overcome, particularly in relation to making locals feel more included and valued, making research and modelling more relevant to local concerns, ensuring effective translation and communication of research findings, and building local interest and trust in the research and modelling results. The interviews also gave me a number of ideas for promoting the research (including suitable venues and forums for public presentations, and local channels for advertising events and presentations) and for encouraging long-term partnerships between the region and researchers. It was with these plans and ideas in mind that I entered the ‘act’ stage of my study’s action research cycle.
Table 4.2. Summary of knowledge transfer opportunities identified by Ningaloo stakeholders during interviews at the study outset.

<table>
<thead>
<tr>
<th>Knowledge Transfer Opportunities</th>
<th>Potential research application</th>
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<tr>
<td></td>
<td>Managing tourism and visitors</td>
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<td></td>
<td>Informing politicians</td>
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<td></td>
<td>Assessing effectiveness of marine park sanctuary zones</td>
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<tr>
<td></td>
<td>Planning for facilities and services in parks and coastal strip</td>
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<tr>
<td></td>
<td>Managing fisheries and the reef</td>
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<td></td>
<td>Developing sustainability indicators</td>
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<td>Planning for Shire infrastructure and service demand</td>
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<td>Assessing proposed developments</td>
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<td>Informing policy</td>
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<td>Using models to assist with collaborative planning</td>
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<td></td>
<td>Using models as learning tools</td>
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<td></td>
<td>Supporting National Landscapes branding</td>
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<td></td>
<td>Regional planning and visioning</td>
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<tr>
<td></td>
<td>Assessing World Heritage impacts</td>
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<tr>
<td></td>
<td>Educating and fostering responsible behaviour among visitors</td>
</tr>
<tr>
<td></td>
<td>Bringing together stakeholders to share information and work together</td>
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<tr>
<td></td>
<td>Address cultural concerns and areas of cultural significance to Aboriginal people</td>
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<tr>
<td></td>
<td>Generating support for funding research and local government services</td>
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</tbody>
</table>

| Promoting research uptake        | Sustain relationships between researchers and local people and agencies |
|                                  | Engage a local research coordinator |
|                                  | Create a regional trust |
|                                  | Partner with landholders and tourism operators to disseminate research results |
|                                  | Build a website |
|                                  | Integrate data with other agencies |
|                                  | Make models accessible and use-friendly |
|                                  | House models in the region |
|                                  | Hire a regional person to support and promote models |
|                                  | Solicit local questions for model runs |
|                                  | Train locals to use models |
|                                  | Demonstrate models around the region |
|                                  | Evaluate and update models over time |
|                                  | Identify and engage key stakeholders in both Perth and the region |
|                                  | Partner with local groups and agencies to communicate research results |
|                                  | Highlight research benefits for local people and businesses |
|                                  | Use proposed Ningaloo Research Centre as a venue for hosting and showcasing research |
|                                  | Use multiple media and venues to communicate research results |
|                                  | Have a 'no-surprises' policy when communicating with government and locals |

| Designing research for uptake    | Make communication proposals a required component of grant applications |
|                                  | Spend more time scoping research projects |
|                                  | Relate research to management |
|                                  | Plan for post-research presence in study areas |
|                                  | Foster interdisciplinary collaboration |
|                                  | Engage community in research process and model development |
|                                  | Employ coordinator to facilitate research-management interface |
|                                  | Be prepared to address conflict |
|                                  | Establish diverse, innovative management committee |
|                                  | Encourage culture that encourages real-life research impact, risk-taking, and collaboration |
|                                  | Incorporate communication and knowledge transfer into performance standards |
|                                  | Consult local agencies when preparing research license applications |
|                                  | Include reporting research findings to local agencies as a license condition |
4.5 Act: Conducting Knowledge Transfer Activities

The following is a chronology of the knowledge transfer activities undertaken collaboratively by the NCC modelling researchers and myself in the Ningaloo region between 2009 and 2010. This section describes the primary ‘act’ stage of my study’s action research cycle. It should be noted, however, that a series of subsidiary and opportunistic plan-act-reflect sub-cycles also emerged within this larger process. This chronology is a synthesis of my own documented observations and adapted excerpts from two papers I co-authored with the modelling researchers who took part the knowledge transfer effort. These papers were: *Modellers can Help Their Research Make a Difference* (Jones, Wood, et al. 2011) and *Assessing the impact of stakeholder engagement in Management Strategy Evaluation* (Fulton, Jones, et al. 2013). They can be viewed in full in Appendices 7 and 8.

4.5.1 Connecting Scientists with Local Stakeholders

4.5.1.1 The knowledge transfer process began by establishing and re-establishing/strengthening connections between modelling researchers and regional stakeholders. Wherever possible I assisted in this process by taking advantage of having a continuous local presence (my collaborating researchers were based out of Perth or out of State) and applying my knowledge-brokering capacity. Kick-off Meeting with NRP Management Coordination Committee

Conducting and compiling the interviews summarised in Section 4.4 allowed me to familiarize myself with the NRP, key stakeholders, and regional concerns and issues. In addition, it gave me a feel for the history and relationships between regional stakeholders and researchers. It also provided me with a wealth of ideas to draw from, in relation to navigating barriers and capitalising on opportunities for knowledge transfer in the region. In September 2009, I went to Perth to meet with members of the NRP’s program’s management coordination committee to discuss my project and the development of a strategic and coordinated approach to knowledge transfer in the Ningaloo region. At the meeting, I presented an agenda with input and recommendations from my initial interview results. These recommendations were as follows:

1. The NRP should consider recruiting a local person with event planning experience to develop a regional event showcasing research results.
2. The NRP should consider recruiting a local person to serve as a research coordinator. This person would help disseminate research updates and results to local communities. They could also be responsible for tracking (via coordination with DEC’s licensing/permits section) and liaising with researchers coming to the region. With a little seed funding this position could become self-funding using community grants, etc.
3. The GDC may be interested in running the proposals it receives through the models to help them with their proposal assessment process.
4. Some stakeholders have demonstrated interest in creating a policy position on fisheries regulations in the area. The models could be used in a facilitated process to help them assess different regulatory options.
5. A regional communications strategy is recommended. The GDC has offered to assist in regional communications for events, etc. The NRP should consider setting up a regional communications working group that includes the GDC and CSIRO and DEC communications specialists.
6. It is important that politicians and high level bureaucrats are targeted in the knowledge transfer process, so they understand and support the use of the models in site, local and regional planning processes.
7. A number of stakeholders are concerned that there may only be a small window of opportunity to ask questions of the models. If people are going to invest time and effort in understanding and developing scenarios/questions for the models, they would like to know that they will have ongoing access to the models in the future.

As a result of the meeting, the idea of establishing a local research coordinator to liaise with researchers and help disseminate research results/news to the local community was taken up by the
NRP's management coordination committee, and $10,000 seed money was committed to the position, with the caveat that part of the coordinator’s role would be to seek further funding to extend the position. In all, the coordination committee took on board most of the input; however the idea of embedding the models in participatory decision-making processes was not carried out, there being no openings for public consultation in the identified planning processes during the time frame of the knowledge transfer process.

4.5.1.2 NRP Management Committee Meetings

In a bid to mainstream my work into their ongoing management of the NRP, the NRP’s management coordination committee invited me to participate further in each of their monthly coordination meetings and other planning activities. This opened a new and important conduit between the region and the NRP, as I was able to use these opportunities to channel regional stakeholder concerns and suggestions directly to the management coordination committee. I also passed along stakeholder advice on how they preferred to be communicated with and how they preferred the research results formatted and delivered. Other modelling researchers in direct contact with regional stakeholders were likewise able to channel advice back to the NRP.

4.5.1.3 Modelling meetings, workshops and presentations

The closure of the NSDO earlier in the year and high staff turnover in key agencies, such as the local DEC and Shire offices, led the modelling researchers to intensify promotion of their research and modelling to different organisations and stakeholder groups, both at the regional and state levels. In particular, researchers renewed one-on-one contact with stakeholders in the region, to inform people about the model capacities, and to garner feedback on modelling scenarios relevant to stakeholders in the region, given current concerns and planning and development activities.

From October 2009 to October 2010, I worked closely with modelling researchers Tod Jones and Beth Fulton, in a collaborative stakeholder engagement process that aimed to introduce stakeholders to both the Ningaloo Destination Model and the simplified ecological model standing in for the In Vitro model (built using Ecopath with Ecosim). The purpose of the engagement was primarily to solicit questions for the models and generate awareness and interest in the potential of the models to assist with decision-making in the region. Stakeholder feedback from the meetings also helped the researchers fine-tune aspects of their models.

My activities in support of these meetings and workshops were consistent with the knowledge-brokering component of the conceptual framework outlined in Chapter 3. I assisted the modelling team by highlighting regional interests and concerns raised in my stakeholder interviews, introducing them to new stakeholders, and assisting with the advertising and development of presentations and workshops. In addition, because of my previous professional experience in stakeholder engagement, I encouraged the modelling team to establish relationships and build trust with local stakeholders as a means of generating some level of local acceptance and ownership of modelling research, and provided possible ways of achieving this.

Behind the scenes I worked both formally (i.e. in meetings) and informally (i.e. in social situations) to build trust with local stakeholders (who perceived the modellers as outsiders) prior to modelling meetings and workshops, to generate awareness and interest among stakeholders with respect to the capacities of the models, and to help different stakeholder groups identify specific modelling questions that addressed their interests. Where possible I also attempted to foster conversations and relationships between locally-based stakeholders.

As the modelling researchers formally engaged with local groups, they worked to improve the clarity of their presentations by using common language and easy to understand formats, and by tailoring the focus of modelling results to be relevant to the interests of specific audiences. I was also able to assist in this regard because of my earlier career role as a science communicator. This experience also enabled the modellers to guide other researchers in making their research findings more accessible to the local community. This addressed concerns expressed by the local
community, who often complained about not seeing any return for the support they give to those conducting research in the region.

In total, twenty-four meetings and workshops were held in the region during my 18-month stay, in locations that included Exmouth, Coral Bay, Carnarvon and three pastoral stations (Box 4.1). This was augmented by numerous informal social interactions I had with local stakeholders where we discussed the modelling and research results.

**Box 4.1.** Modelling meetings, workshops, and presentations held in the Ningaloo region between October 2009 and October 2010.

<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>18 Sep</td>
<td>Meeting with DEC to discuss questions for modelling workshop</td>
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<tr>
<td></td>
<td>20 Sep</td>
<td>Meeting with Shire of Exmouth to discuss questions for modelling workshop</td>
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<tr>
<td></td>
<td>28 Sep</td>
<td>Meeting with Shire of Carnarvon to discuss questions for modelling workshop</td>
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<td></td>
<td>6 Oct</td>
<td>Presentation for Cape Conservation Group</td>
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<td></td>
<td>7 Oct</td>
<td>Meeting with DEC re turtle and whale shark modelling</td>
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<tr>
<td></td>
<td>16 &amp; 19 Oct</td>
<td>Ningaloo Tourism Futures Modelling Workshop</td>
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<tr>
<td></td>
<td>20 &amp; 21 Oct</td>
<td>Ningaloo Tourism Futures Modelling Workshop</td>
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<tr>
<td></td>
<td>22 &amp; 23 Oct</td>
<td>Ningaloo Tourism Futures Modelling Workshop</td>
</tr>
<tr>
<td>2010</td>
<td>10 Feb</td>
<td>Presentation &amp; meeting with Quobba Station</td>
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<tr>
<td></td>
<td>10 Mar</td>
<td>Presentation &amp; meeting with Shire of Carnarvon</td>
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<tr>
<td></td>
<td>8 Mar</td>
<td>Public Presentation in Carnarvon</td>
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<td></td>
<td>9 Mar</td>
<td>Presentation to Tourism Strategy Steering Group</td>
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<td></td>
<td>10 Mar</td>
<td>Presentation &amp; meeting with Quobba Station</td>
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<td></td>
<td>10 Mar</td>
<td>Presentation &amp; meeting with Gnaraloo Station</td>
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<td></td>
<td>11 Mar</td>
<td>Presentation &amp; meeting with Warroora Station</td>
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<td></td>
<td>13 Mar</td>
<td>Public Presentation in Coral Bay</td>
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<td></td>
<td>15 Mar</td>
<td>Public Presentation in Exmouth</td>
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<tr>
<td></td>
<td>16 Mar</td>
<td>Presentation to the Shire of Exmouth</td>
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<td></td>
<td>17 Mar</td>
<td>Presentation to the Whale Shark Operators</td>
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<td></td>
<td>25-26 Oct</td>
<td>Carnarvon Ningaloo Modelling Training Workshop</td>
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<td></td>
<td>25 Oct</td>
<td>Public Presentation in Carnarvon</td>
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<td></td>
<td>28-29 Oct</td>
<td>Exmouth Ningaloo Modelling Training Workshop</td>
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<td></td>
<td>28 Oct</td>
<td>Informal dinner with modelling researchers and local stakeholders</td>
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<td></td>
<td>29 Oct</td>
<td>Public Presentation in Exmouth</td>
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4.5.2 Establishing Regional Boundary Spanning Entities

As the knowledge transfer process progressed, three locally-driven boundary spanning initiatives emerged in an effort to formalise linkages between NRP scientists and the region: a regional reference group, a regional research coordinator, and the proposed Ningaloo Research Centre.
Further conversations between myself and key local stakeholders led to the formation of an informal Regional Reference Group that involved, amongst others, the Exmouth Chamber of Commerce, the local conservation group, the GDC, DEC and the Exmouth Visitors Centre Marketing Committee. The group served to some extent as a temporary and informal community of practice (as per Wenger 2005), and created a new set of connections across institutional boundaries. I facilitated the group, which met nine times between February and December 2010. The Regional Reference Group provided suggestions for regional roll-out of the NRP communications strategy, suggested content for regional communications, promoted local presentations and provided advice about the timing of events. The group also made the decision to link the research coordinator position (see below) to the reference group, by making the coordinator its chair. Information generated by the research began to circulate more broadly and more often through this group and through my knowledge-brokering activities.

Upon forming, the reference group attempted to prepare a terms of reference for itself (Appendix 9); however, because the group’s formation generated political anxieties among some of the agencies involved in the research program (see below), the terms of reference were discarded and the group remained wholly informal.

A suggestion generated through my conversations with stakeholders was for a part-time regional research coordinator to work with stakeholders to promote research more broadly in the region and to ensure use of the models in regional planning and assessment processes. This role was initially funded with contributions from three NRP projects for a six-month period. The GDC saw an opportunity to link the coordinator position to one of its proposed projects, the Ningaloo Research Centre (a regionally-based educational research facility—see below) and offered to sponsor and help fund the role. Importantly, this decision also created an opening for the GDC to become more formally involved in the NRP’s knowledge transfer process.

There was some delay in hiring the coordinator due to slow action on the part of the NRP’s management coordination committee. Eventually a regionally-based person was hired just prior to my leaving the region, with the intention that he would take over the knowledge brokering role I had been playing. It was hoped that he would maintain the stakeholder relationships I had built up during my previous 18 months spent in the region and continue promoting use of the models for planning and decision-making, via the regional reference group.

During my initial round of stakeholder interviews, a number of interviewees noted that the Shire of Exmouth and the GDC had been pursuing funds for a number of years to build a regional research centre in Exmouth. The idea of the centre was that it would be a place to host scientists, translate research and educate the public on research being done in the area. A centre like this could serve as a boundary organisation. In further discussions, both the Shire and the GDC indicated their belief that the centre would be an ideal place to showcase findings from the NRP and host the NRP’s models. Many of the discussions during the reference group meetings were related to finding ways of dovetailing the NRP’s knowledge transfer aspirations with local aspirations to build the research centre. There was some hope that the research coordinator position could be extended and likewise be integrated into a role at the research centre, should it succeed in getting funded. It was also suggested that the reference group could continue to function as a community advisory group for the Ningaloo Research Centre. It was my hope that this group would persist and serve as informal community of practice that would help foster relationships to bridge the research-management gap in the Ningaloo region.

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28 It should be noted that the two Visitors Centres had been closely involved in the research, but this required re-engagement following manager turnover in Exmouth and Carnarvon.
Chapter 4

4.5.3 Communications Planning

Traditional approaches to knowledge transfer have tended to focus on communication, or one-way flow of information from researchers to managers and the public (Land & Water Australia 2006). As such, communication as well as stakeholder engagement was part of the NRP’s effort to engage with agencies and a broader audience. This involved the creation of a communications strategy through the CSIRO’s Communications section. The plan incorporated both communication and engagement objectives (Longeran et al. 2011). The Regional Reference Group, and me separately, prepared advice on how to best to communicate and engage with people in the region. This advice was channelled to CSIRO’s communication’s section via my participation in the monthly management committee meetings. The research coordinator, once hired, was also involved in the latter stages of the plan development.

The NRP showcased its final research results at the May 2011 Ningaloo Whale Shark Festival, held in Exmouth. The research coordinator invested a considerable amount of time ensuring that NRP booth was well profiled at the event, and also organised a public presentation of the final research results. In addition, upon their completion, detailed research results and reports were made available on the NRP, WAMSI and CSIRO websites, and loaded onto the online Ningaloo Atlas. A number of multi-media tools were also developed that allow the public to play with ‘toy models’ online (Fulton, Gray, et al. 2011).

4.5.4 Modelling training & Adaptive Management Workshops

As noted in Chapter 3, adaptive management is a process that can be used to link science with decision-making. During the course of stakeholder meetings, some stakeholder groups asked for training on how to use the models and in adaptive management. In response, in March 2010 the modelling researchers hosted modelling and adaptive management workshops in the Ningaloo region. These were two-day training sessions that brought together participants from a variety of local agencies and groups. Dr Fabio Boschetti (CSIRO), Dr Bill DeLaMare (CSIRO) and Dr Ben Radford (AIMS, UWA) assisted with these workshops. Participants learned about adaptive management, the Ningaloo models, and other information tools such as the Ningaloo Atlas. Participants were also given hands-on opportunities to run the models using different scenarios. An overall evaluation of the workshops and their outcomes and lessons learned was prepared by Tod Jones (Appendix 10). The results from six evaluation questionnaires completed by participants are also located in Appendix 10.

The workshop was reasonably well attended in Exmouth (8 participants), but struggled for numbers in Carnarvon (2) and Coral Bay (3). Participants in Exmouth were from a variety of institutions including the Shire, an NGO, DEC, and the GDC, and brought with them a broad range of professional experience and agency orientations. Participants at the Carnarvon workshop included a representative from the GDC and another from the Shire. Unfortunately, other events running concurrently in Carnarvon prevented three other key invitees from participating in the training. In Coral Bay, numbers were low because of road closures due to flooding on the pastoral stations.

Evaluation took place through both discussion and written feedback. In Exmouth, a senior Shire staff member said that, “Never ever until today, have I thought about how planning affects what happens in the water.” Another participant in Exmouth stated that he now was asking what “type of tourism” would be good for Exmouth, rather than “tourism per se” (Appendix 10). With respect to written evaluations (Appendix 10), all of the participants indicated their knowledge about MSE, adaptive management and the NDM has increased somewhat or a great deal. However, when asked if they now felt adaptive management or modelling could address their concerns or interests in the region, only three participants responded, all with “agree”. When asked what they intended to do upon completing the workshop, three responses were provided, including: “consider implementing program within council operations”, “play with the Ecosim model”, and “this is the one question I was left with after 2 days; still don’t know”. In terms of workshop strengths, one respondent stated that it “really got a diverse group of people talking”,

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and another stated “sharing ideas with other organisations”. Two other comments related to quality of presentations and another related to the opportunity to use the models.

4.5.5 Project Closure

From July to October 2011, I undertook a final round of evaluation interviews with a subset of stakeholders. The purpose of this interview round was to assess the effects and outcomes of the knowledge transfer process from a stakeholder perspective. This evaluation process is described and the results of the interviews are discussed in Section 4.7 below and presented in full in Appendix 11.

In September 2011, I made a final attempt to bring a selection of regional stakeholders together around an issue I felt would benefit from multi-stakeholder discussions and application of the NRP models. I organised an informal lunch with members from the Shire of Exmouth, the GDC, the local DEC office, the NW Cape Conservation Group, the Centre for Whale Research, the NRP’s regional research coordinator, and an interested community member. The impetus of the lunch was a series of new petroleum exploration and supply base proposals for the Exmouth Gulf, brought to my attention by the Cape Conservation Group. The lunch gathered together a number of people who had not met face-to-face before, including a Shire Councillor and the new Shire CEO. Outcomes of the meeting included a decision by the Shire to send out a community information notice outlining the pros and cons of exploration in the Gulf. It also led to the Shire requesting that the NRP modellers run scenarios for projecting potential cumulative impacts for the different proposals. As follow-up from the lunch meeting, the Shire CEO suggested having regular heads-of-agency meetings, which he planned to link with bi-annual community information sessions.

On October 20th, 2011, just prior to leaving the Ningaloo region, I presented my preliminary research findings at a community meeting hosted by the Shire of Exmouth. My offers to conduct a presentation for the Shire of Carnarvon were not taken up. The Exmouth presentation was part of a write-up in the local newspaper the next day.

4.5.6 Preliminary Outcomes and Indications of Research Uptake

Rounds of meetings between researchers and stakeholders appeared to generate some interest in using the models for decision-making in the region. This culminated in requests for modelling training, which was fulfilled by the modelling researchers in March 2010. In 2011 discussions had been underway about using the models to help inform different planning processes taking place in the region. One of the Exmouth Shire’s staff expressed interest in using the models for a community visioning process. Some other stakeholders expressed an interest in using the models as a tool to facilitate multi-stakeholder discussions and decision-making in relation to planning and development proposals.

There was also considerable interest in seeing the models housed locally, together with a locally based modelling support person (possibly the NRP’s regional research coordinator). The GDC and the Ningaloo Research Centre were suggested as suitable regional hosts for the models.

It was hoped that the reference group would persist as an informal community of practice that would help facilitate the interface between science and management in the region, with the assistance of the research coordinator in his knowledge brokering capacity. This would have serviced as a knowledge transfer model consistent with the conceptual framework developed in Chapter 3. However, the coordinator did not reconvene the reference group after I left, and focused instead on helping develop the CSIRO communications strategy, building a presence for the NRP at the region’s Whale Shark Festival (see below), and assisting in the development of grant applications for a community monitoring program. Nor was he able to secure funding to extend the research coordinator position beyond its initially funded six-month life span. In essence, knowledge brokering ceased in the region after I departed.
The Ningaloo Research Centre may have provided the necessary impetus for the persistence of the reference group and research coordinator; however, as of 2012, funding had not yet been secured for its construction.

4.6 Reflect: Researchers’ Perspectives on the Knowledge Transfer Process

After the final 2010 knowledge transfer activities were completed, Tod Jones, Beth Fulton and I co-wrote a chapter for the final NCC report on the socio-economics of tourism: Modellers can Help Their Research Make a Difference (Appendix 7; Jones, Wood, et al. 2011). This chapter serves as a reflective chronology of the knowledge transfer activities we jointly undertook between 2009 and 2010. First, it looks at the challenges faced by modelling researchers in the Ningaloo system, and how these challenges necessitated a flexible, emergent approach to a participatory modelling process. Second, it looks at the emergence of adaptive behaviours among researchers and within the research program, and among groups and organisations in the Ningaloo region. Finally, it examines the factors that inhibited the emergence of these new behaviours. The report chapter was written from a ‘complexity’ perspective and a view of the Ningaloo region as a complex adaptive system. However, it should be noted that the chapter was also written prior to completion of my theoretical investigation and prior to completion of my stakeholder evaluation interviews. As a result, my personal perspective on the process has since evolved and will be outlined in Part III of this thesis. At the end of the project, I also co-authored a paper (Fulton, Jones, et al. 2013) which provides an overview of stakeholder engagement undertaken in relation to the Management Strategy Evaluation (MSE) project (which enfolds both the NDM and InVitro modelling projects), from its start-up in 2005 to 2011 (both in Perth and in the Ningaloo region). The paper also outlines how stakeholder engagement affected the unfolding of the MSE project. It can be viewed in full in Appendix 8.

Key excerpts from these two collaborative accounts are summarised and synthesised below and compared to some of the conceptual framework and supporting literature outlined in Chapter 3. These accounts contribute to the ‘reflect’ stage of my project’s action research cycle.

4.6.1 An Emergent Approach to Knowledge Transfer

Ningaloo presented a number of challenges that made it difficult to apply a structured approach to knowledge transfer. These challenges can be linked to the turbulent nature of organisations and stakeholder groups in the Ningaloo region. This turbulence is largely attributed to: high staff turnover within government agencies; low connectivity between organisations and individual stakeholders; and a political decision to dismantle the region’s centralised planning body, the NSDO.

The researchers in this study (the modelling researchers and myself) addressed these challenges by adopting an emergent approach to knowledge transfer. Notably, they engaged stakeholders in ways that helped increase the diversity and intensity of interaction between agents (stakeholders and researchers) operating in the region, which Stacey (1996b) and Seele (2006) argue increases system responsiveness and adaptability. Examples of activities that constituted an emergent knowledge transfer approach included the following:

- Agreeing to the involvement of a regionally-based knowledge broker (myself) to help foster dialogue and relationships between researchers, practitioners and policy makers.
- Intensifying one-on-one interaction with stakeholders via meetings and interviews, and allowing next steps to be shaped through these interactions.
- Tailoring model runs to be more relevant to regional concerns and needs through dialogue with stakeholders.
- Partnering with local agencies and using local networks to plan, develop and implement knowledge transfer activities, including meetings, presentations, events and training sessions, as well as more conventional media-based communications.
These activities are consistent with the conceptual framework outlined in Chapter 3, in that they emphasise relationship building as a means of improving research uptake, and participatory processes as a means of linking scientists and decision-makers.

As the NRP engaged local stakeholders, the connectivity, information flow, and the diversity of groups engaging with the modelling research increased. This became most effective once I took up my role as knowledge broker in the region. As per the conceptual framework in Chapter 3, my knowledge brokering activities helped facilitate engagement by creating and/or renewing connections through many local conversations. These connections helped the modelling team generate new ideas and increase their penetration into the community and local organisations.

My long-term presence in the community also helped researchers tap into regional communication networks and identify potential locally-based partners for assisting with knowledge transfer in the region, most notably the Gascoyne Development Commission (GDC). The GDC is a key player in the region because they have a strong network of relationships with all of the region’s key stakeholder groups. They are also important because they are viewed locally as relatively politically neutral (unlike DEC or the Shires).

The interactions between researchers and stakeholders triggered a number of emergent behaviours among some groups and organisations in the Ningaloo region. Local individuals and groups took more interest in using the modelling research for decision-making and began to self-organise in ways that facilitated the transfer of modelling knowledge and capacity. These included: partnerships between local agencies and research bodies, tapping of local communication networks by research bodies, self-organization of a locally-based research reference group, and establishment of a local research liaison position. From the perspective of the conceptual framework outlined in Chapter 3, these behaviours can be understood as arising from the tacit knowledge generated by the engagement process.

Where multiple organisations are involved in managing a resource, as is the case for Ningaloo, the modelling also needs to generate new connections between the organisations. This builds regional capacity to effectively use the modelling tools and the research. The Regional Reference Group is an example of how this can happen. This group had the potential to become an ongoing informal community of practice that could facilitate the interface between science and management in the region. Such an umbrella group could also potentially provide coordination across planning processes and management decisions.

4.6.2 Effect of Stakeholder Engagement on Modelling & MSE Projects

The stakeholder engagement component of the knowledge transfer process proved to have a two-way impact in that it not only resulted in the emergence of new behaviours among groups in the Ningaloo region, but also changed how the NRP models were developed by researchers, and how the overarching Management Strategy Evaluation (MSE) project (into which the models fed) unfolded.

Figure 4.5 summarises how the stakeholder engagement was expected to occur at the MSE project inception. Stakeholder interactions were expected to happen mainly a) at the beginning of the project, when local information is collected and modelling objectives are discussed and simulation scenarios designed; and b) in the last stage of the project, when model results are delivered. This is consistent with the traditional ‘pipeline’ model of knowledge transfer noted in Chapter 3.

A timeline of the actual stakeholder and research interaction is depicted in Figure 4.6. Clearly, the actual stakeholder engagement process was far more intensive, unplanned and non-linear than was conceptualized at the beginning of the study. Stakeholders were first engaged early on, prior to commencement of the MSE project. Unfortunately, staff turnover and illness interrupted this process. Two years later, the modelling team restarted and carried out the process directly (my entrance into the project is indicated on the lower level of the timeline). This included several one-to-one meetings and workshops with other scientists, local and state government organisations and
local communities. A total of seven trips were made to the Ningaloo region by different team members. These interactions between team members and stakeholders allowed for model improvement and acceptance and also helped highlight the questions the model needed to address. As such, the actual engagement process turned out to be consistent with more recent participatory approaches to knowledge transfer, as per the conceptual framework outlined in Chapter 3. Consequently, interactions between stakeholders and researchers were enhanced, and the usefulness of the research was improved in terms of being salient, credible and legitimate.

Moving from the expected engagement process to the more participatory process outlined in Figure 4.6 involved not just considerable adjustments to the project plan but also changes in priorities and effort allocation. While no staff had been specifically allocated to stakeholder engagement over the entire project, at the time of project completion a considerable amount of effort was dedicated to organising meetings, workshops and related travelling, and initiating and following a considerable flow of e-mail and phone communication. According to calculations at project completion, stakeholder engagement accounted for approximately 43% of the effort of the overall modelling team (this did not include my own effort), the remaining going to data collection, model development, and parameterisation and result visualisation.

This clearly indicates that applying the conceptual model in Chapter 3 comes at a high price in terms of resource allocation. The way in which the MSE project unfolded demonstrates that assessing who and what will influence the impact of models as decision-making tools (recognising that this will continuously change from project start to finish and therefore must be continuously tracked), and cultivating and maintaining essential relationships accordingly requires a significant investment of time and resources over the entire length of the modelling project. In addition, considerable skill and experience on the part of those conducting the engagement is required. It also highlights the importance during project inception of properly planning for the capacity, time and resources needed for stakeholder engagement, and understanding the characteristics of the locations and organisations that will be targeted for engagement. Planning, however, must also be sufficiently flexible to accommodate emergent activity and take advantage of opportunities as they arise.
4.6.3 Inhibiting Factors

During the engagement process, new behaviours began emerging among groups and organisations in the region. However, these emergent behaviours were countered by a number of inhibiting factors. These factors were largely related to the NRP’s management coordination committee being somewhat traditionally-structured in terms of its composition, role and operation in overseeing research outputs, rather than being structured to respond effectively to opportunities and relationships emerging from research activities. Although the management coordination committee was flexible in its approach, recognised the importance of local engagement and communication, and was prepared to invest additional resources to encourage research uptake, it is still worthwhile examining the particular structural issues that inhibited emergence. It should also be noted that all of these inhibiting factors are related to commonly encountered barriers to building adaptive institutions, as identified in the literature and detailed in Chapter 1.

4.6.3.1 Anxiety among committee members

The new set of activities that followed my entry into the region were supported by the NRP’s management coordination committee, although this was not without apprehensions. Historical tensions between agencies and stakeholders in the region created anxieties about affiliating the

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29 Only scientists, not stakeholders, were represented on the committee. Stakeholders were not involved in the research planning phase.
30 The lessons learned by the NCC’s coordination and management committee as a result of the stakeholder engagement process are outlined by Longeran et al. (2011).
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NRP with a regional reference group consisting of polarised stakeholders. This was particularly so given the potential for conflict over negotiations for the excision of the two kilometre coastal strip from the pastoral stations (the excision itself being a ‘wicked’ problem). Concerns related to the make-up and purpose of the reference group, and who, if anyone, would control it. This relates to Pritchard and Sanderson’s (2002) observation that bureaucracies will resist innovations that potentially undermine agency power structures and stability, and which present political risks (Lee 1993; Walters 1997).

Hiring the regional research coordinator was also delayed due to concerns within the management coordination committee. The first preferred candidate for the position eventually chose not to take the position due to these concerns and delays.

4.6.3.2 Lack of proportionate control/local representation

Anxiety within the management coordination committee constrained its capacity to move on emerging opportunities for knowledge transfer in the region. The composition of the committee reflected its purpose—managing the progress of the research projects. It was originally comprised of senior researchers and project leaders, but later came to include project communications officers and researchers with links to the local communities, including myself. Local groups, however, were not represented, so anxieties over new activities in the region were not balanced by assurances from regional organisations on the potential benefits of these new opportunities. As such, lack of proportionate power slowed the dissolution of anxiety. This connects to the argument that separating science and the public increases miscommunication as the flow of important information between scientists, managers and other stakeholders is blocked (Norton 2005). It also supports the emphasis participatory researchers put on community empowerment and control during the research process, and the role of genuine participation in bridging the science-management divide, as per the conceptual framework and literature reviewed in Chapter 3.

4.6.3.3 Slow acting committee

The major issue, however, was not so much the concerns noted above (although these are pertinent), but the rate at which information flowed back to the region. Once new activities began to emerge, the management coordination committee and researchers were generally supportive but tended to respond slowly through monthly meetings, with concerns sometimes only being raised in subsequent meetings. Research institutions tend to respond slowly to new opportunities because (i) their role is perceived to primarily be in research oversight; and (ii) their attention is divided between that particular body of research and the many other projects and responsibilities they have. It is worth noting that these delays arose despite the management coordination committee’s willingness to adapt and take advantage of new opportunities. Such delays are potentially unavoidable given the nature of modern research bodies.

Perhaps most importantly, despite being positive and supportive, the management committee’s slow response time likely led to missed opportunities, as the impetus for change in the region moved much more quickly and had slowed by the time the committee came back with decisions. This committee’s willingness to engage and be responsive to stakeholder needs demonstrates a shift away from Roux et al.’s (2006) observation that such committees are often unwilling to step outside their “comfort zones” and prioritise relationship building over producing outputs (reports etc.) and transferring information.

4.6.3.4 Process for developing the communications plan

Tensions between adaptive and more staid organisational structures also arose around the development of a communications plan. Institutional protocols (designed to keep relevant regulatory and ministerial bodies informed, and avoid potentially politically embarrassing situations) mean that there is typically a high degree of in-house control over public relations processes. Again, this is related to the aversion bureaucracies have to political risks.
Consequently, local and researcher involvement, outside of management committees, tends to occur once the plan is fully formed, rather than through a process that occurs across the development of a communications plan. Unfortunately this can restrict connectivity, and impacts upon the potential uptake of the information, reducing the likelihood of information circulating broadly if regional stakeholders (and the community more broadly\textsuperscript{31}) do not feel engaged.

4.6.3.5 Failure to tap into local research aspiration

A second point of local interest was the Ningaloo Research Centre. The proposed Research Centre was backed by the GDC and had strong local support and a board with excellent community networks. However, universities and researchers wanted little to do with the Research Centre due to concerns over the ongoing funding required by buildings. Institutional sensitivities are acute around liabilities associated with whether or not a body is a legal entity and are linked to past experience where other informal bodies showed much promise but never made it to an independent, self supporting status and collapsed (even after considerable injection of funds, effort and time). While NRP researchers did provide advice about how to attract scientists and ongoing funding, the proposed Research Centre was never viewed as an opportunity to promote research in the region or engage with regional organisations.

This may have been a missed opportunity on the part of the NRP management committee, as the Ningaloo Research Centre has the potential to serve as an ongoing catalyst for building and supporting an informal community of practice in the region, one which would help facilitate relationships at the science-management interface, as per the conceptual framework and supporting literature outlined in Chapter 3.

4.6.3.6 Research funding cycle & fly-in-fly-out research

Just as regional tourism and extractive industries can be conceived as complex adaptive systems, tourism and research also form a complex adaptive system, with an important control variable being the research funding cycle (a slow moving variable). The adaptive cycle of research has its own ‘collapse’ phase, similar to that noted in Gunderson and Holling’s (2002) panarchy model, where researchers consolidate their activities at the end of a project while looking for the next research opportunity. Unfortunately, researchers (such as myself in the case of this study) wind down their engagement with the region at the time when their research is most likely to stimulate adaptive behaviour. Based on the poor uptake of some of its previous research, the CSIRO was aware that opportunities for research uptake and ‘impact’ can be lost in part because the shifting focus of researchers. Consequently, CSIRO has provided additional funding to ensure that the model promotion, training and use will continue beyond the life of the project. Nonetheless, this funding has a limited lifespan. Modellers are still absent from the region for long periods, an issue that will only be resolved if the models are located in the region where they can be accessed by locals or a regionally-based facilitator.

This, together with the absence of local representation in the NRP’s management coordination committee, reflects Roux et al.’s (2006) argument that science-management relationships typically do not represent true partnerships or operate for long enough time frames (5-10+ years) to build the high levels of trust and knowledge flows needed to develop better futures. On Parkes & Panelli’s (2001) continuum of participation in research (Table 3.2), the mode of local participation used by the NRP would rate as ‘co-option’ or ‘consultation’, as locals had no real input or opportunity for power sharing in the research program.

However, CSIRO is looking into other collaborative long-term solutions. As much of the information flow in the Ningaloo system has relied on preliminary results (and needs to as stakeholders will not remain engaged if the modellers “go silent” for years as they work to final

\textsuperscript{31} It is worth remembering that in small population centres, such as those in the Ningaloo region, the local community puts a good deal of weight in local representation and distrusts external influences. Thus disaffection of local representatives with the engagement process can have a cascading effect across community attitudes, in a way that would seem disproportionate in larger settlements where there are many competing information networks and representational bodies.
model results), the continued funding is needed to ensure ongoing connectivity and information flow until the final research results are available, and perhaps beyond.

4.6.4 Summary

While acknowledging the complexity and adaptive nature of the system being modelled, the methods for undertaking modelling projects are often conceived as if they were occurring in a relatively controlled environment. For instance, the researchers assume that the same group of people will be involved throughout the course of a modelling project, that priorities remain constant, and that the people who are involved will influence policy decisions (van den Belt 2004). These are not realistic expectations in a turbulent system that is characterised by constant change, high staff turnover, and low connectivity between groups. Because tourism and other extractive industries are part of complex social-ecological systems, they tend to be turbulent (dynamic and unpredictable) and suffer from ‘wicked’ problems, and therefore resist planned or controlled changes (Stacey 1996a; Stacey et al. 2000).

Researchers can increase diversity and connectivity among the people (agents) in the system under study by iteratively conversing with a range of stakeholders in the process of developing models and promoting model uptake (as per Shaw 2002; Stacey 1996a; Stacey et al. 2000). In the Ningaloo case, as researchers and research administrators intensified their interaction with regional stakeholders they became more responsive to stakeholder needs and concerns. In other words, they became more adaptive.

This behaviour on the part of researchers then triggered emergent behaviours among some groups and organisations in the Ningaloo region. Local individuals and groups began to have more, albeit limited, interest in using the modelling research for decision-making, and began to self-organise in ways that facilitated the transfer of modelling knowledge and capacity. As these new patterns of behaviour emerged, they were countered to a degree by a number of inhibiting factors, including anxiety among some researchers and institutional actors, the response time to emerging local behaviours, lack of local representation, and the structure of the research program and its funding cycle.

4.7 Reflect: Stakeholder Perspectives on Outcomes

Between July and October 2011, I undertook a separate assessment of the knowledge transfer process by conducting a final round of evaluation interviews with a subset of eleven stakeholders, eight of whom gave me permission to use their research results. These eight stakeholders represented different regional and research interests in the Ningaloo area. Included among them were community, private sector and agency members from the Ningaloo region, and scientists who had been involved in the knowledge transfer activities. The purpose of these interviews was to evaluate if and how a cross-section of stakeholders (including scientists) were affected by the knowledge transfer process, and to reveal the different forms of knowledge (if any) that were generated, as per the conceptual framework outlined in Chapter 3. The interview questions specifically focused on identifying changes in:

1. What stakeholders know (representational knowledge; knowledge as object)
2. How stakeholders are doing things (outcome of reflective knowledge; knowledge as acting)
3. Relationships between stakeholders (relational knowledge; knowledge as a process of relating)
4. Stakeholder perspectives (reflective knowledge; knowledge as reflection)

I compiled the interview results (organised by theme) into a document (Appendix 11), then circulated copies to all those I had interviewed and to the NRP’s program’s management coordination committee. A summary of the results is presented below and discussed in relation to the conceptual framework and supporting literature outlined in Chapter 3, as well as the literature reviewed in Chapter 1. A more in-depth discussion of these results in relation to my theoretical...
investigation will be presented in the final chapter of this thesis. In this summary, the results from the scientists are distinguished from those of locally-based stakeholders for comparison purposes.

4.7.1 Types of knowledge generated

4.7.1.1 Do you know anything now that you did not before?

This first question was designed to test for generation of representational knowledge (i.e. explicit knowledge) during the knowledge transfer process. When first asked this question, half of the eight interviewees were unable to answer right away, either saying no or they were not sure, despite all having been primary targets for knowledge transfer by the Ningaloo research program. When pressed, some of the locally-based stakeholders noted that they had learned more about the general environment, tourism, oil and gas, and the community itself, but most were unable to cite specific facts or figures off-hand. They did indicate, however, that they were more aware of the research program and the models that have been produced. Given the large amount of scientific information that was conveyed during the knowledge transfer process, these results indicate that the local stakeholders, who were the intended recipients of the knowledge transfer process, gained less representational knowledge than expected.

One of the scientists indicated that they had learned a number of things from running their models. For example, the models showed that there is a large conflict between marine environment and the social well-being of the community, in that Exmouth needs more economic stimulus, and the marine environment is more fragile and unpredictable than expected. The scientists also indicated that they had learned things through the stakeholder engagement process, including what some of the biggest pressures/drivers on Ningaloo system are (e.g. facilities and access). They also noted they had learned about the importance (and difficulty) of meaningful communication and stakeholder engagement to the success of research and modelling projects.

4.7.1.2 Are you doing anything differently?

The second question was designed to test for actions that were changed or generated as a result of the knowledge transfer process. This is relates to the conceptual framework in Chapter 3, whereby action is understood to arise from reflective knowledge (which is a component of tacit knowledge). This is an important test as it pertains to Roux et al’s (2006) argument that knowledge transfer efforts which do not result in adoption or use of that knowledge are failures.

Only one interviewee indicated that they were not doing anything differently as a result of the knowledge transfer process. Locally-based stakeholders highlighted that the knowledge transfer process had resulted in improved networks and communications between stakeholder groups, more openness between groups, breaking down of silos, and greater contact with researchers. There was also mention of becoming more involved with conservation and the community. When asked if they had shared anything they had learned with others, most of the stakeholders indicated that had shared some information with their immediate circles.

There were mixed opinions about whether the models would be used by local agencies for planning. Some comments indicated the models were too complicated, another interviewee suggested they would like to use them but was not sure, and another indicated they were quite keen to use the models. Other outcomes in relation to local governance included an application for a Shire environmental officer, and stated intentions by local agencies to increase their focus on community consultation. One interviewee expressed an intention to practice more adaptive management.

Some of the scientists indicated that they had made changes in how they approach modelling and research (e.g. being more flexible and adaptive), changed how they communicate science, and increased their focus on stakeholder engagement. The scientists also indicated that engagement with regional stakeholders had resulted in some spin-off projects, including an application to fund research staff at the proposed Ningaloo Research Centre.
Although all but one stakeholder indicated that their actions had changed as a result of the knowledge transfer process, most of these changes related to how they interacted with other groups and individuals, rather than application of scientific knowledge. Thus, it seems knowledge transfer did indeed change people’s actions and behaviours, but little in the way of applying research to decision-making and management. As such, the process appears to have had limited success by Roux et al.’s (2006) definition of successful knowledge transfer. However, as noted in Chapter 1, the adaptive capacity of institutions is improved by collaborative processes and improved relationships between stakeholders. So, paradoxically, in terms of improving regional adaptive capacity, the knowledge transfer process can perhaps be viewed as having had a positive effect, despite the apparent failure in knowledge transfer.

4.7.1.3 Do you associate with anyone new or differently?

This question was intended to test for the generation of relational knowledge (the other component of tacit knowledge) during the knowledge transfer process. A couple of the interviewees initially suggested that they were not really associating with anyone new as a result of the knowledge transfer process; however, as the conversation progressed they indicated they had developed some new relationships. Locally-based stakeholders indicated that they had developed relationships with some researchers, especially Tod Jones and Beth Fulton, and with other groups in the regions. Notably, a number of interviewees stated that relationships between local agencies and groups had improved as a result of the process. The scientists indicated that they had developed new relationships with other researchers, and with people from the local community and local agencies.

When asked to describe the nature of their new relationships, common themes included informal and friendly, and professional and friendly. Candidness, respectfulness, trust, inclusiveness and willingness to share were also mentioned. One local interviewee, however, did notice that as a result of their outward support for World Heritage, their relationships with some people in the community had changed in a negative way.

These results show that relational knowledge increased for most of the interviewees as a result of the knowledge transfer process. Again, this suggests a positive effect in relation to improving and expanding relationships between stakeholders in the region, and thereby improving regional adaptive capacity.

4.7.1.4 Has your thinking or perspective changed on anything?

This question was intended to directly test for reflective knowledge (a component of tacit knowledge). One locally-based interviewee stated that their perspectives had not changed as a result of the knowledge transfer process, except in relation to what they learned at the Ningaloo Symposium. Another stated that although they could not cite specific figures as a result of the knowledge transfer process, they did feel they had more insight and awareness generally. Another stated that the process had strengthened their existing beliefs. Other locally-based stakeholders stated that the process had opened their eyes to new ways of communicating with different groups, and the idea that getting information out to the community could be a responsibility shared between different groups and agencies.

Some locally-based stakeholders also indicated that they were more open to environmental concerns and more aware of the implications of their actions. Comments were also made about thinking more about change and the future, the importance of World Heritage, and the effects of the tourism cycle. Another noted that the theme of adaptive management had really come through as had the need for using it in their day-to-day practice.

The scientists interviewed indicated that the process had changed their perspectives on the role of the science (that it needs to take a more active role), and they now believe that greater investment needs to be put into interpreting science. They noted that they now recognize the need for adaptive/flexible approaches to modelling, focusing on what people need and want, and valuing and incorporating anecdotal and local information.
With respect to changes in how others think, local interviewees indicated that they believed the process had made community members more aware of the research that has taken place, thereby helping diffuse divisions between ‘them’ and ‘us’. Those that had been targeted specifically for intensive training were perceived to be more open-minded about the models. However, it was also noted that there is still a barrier between scientists and the community, and that the general community was still quite sceptical of some of the information generated by the NRP.

These results indicate that while the knowledge transfer process did not appear to change the perspectives of one stakeholder, it did have some effect on those of the others. Most notably, both the locally-based and scientific stakeholders expressed a new appreciation for the value of collaborating and engaging with others. The process also appeared to somewhat increase people’s ‘systems thinking’, in terms of thinking about change, indirect impacts, and the future.

4.7.2 Stakeholder evaluation of knowledge transfer process

4.7.2.1 What are your overall thoughts on how the process went?

In general, a number of the interviewees indicated they appreciated the effort that was made to transfer knowledge, particularly relative to the effort made by previous projects, but that they were not sure how well it worked or how big an impact it had made. One of the scientists noted that it had been a very adaptive process and that this would likely become a basis for how they do things in the future. It was also noted that the knowledge transfer process was assisted by the imperative created by recently proposed developments and by the fresh slate created by new managers taking over most of the Exmouth-based agencies.

In relation to NRP communications, locally-based stakeholders largely indicated that they had not really looked at the NRP and Ningaloo Atlas websites, and those that had thought the available information was limited. There was positive feedback regarding community presentations, the Whale Shark Festival, and the Ningaloo Symposium. Concern was expressed about making sure research results are conveyed to private interests as well as government agencies. Concern was also expressed about the availability of concrete information, delays in seeing final research results, providing reasonable access to the research results, and leaving something behind for the community. A mention was also made that one public research presentation presented results that were very different to local people’s estimation of the situation. This had the effect of making them sceptical about other research that was presented.

The importance of the proposed Ningaloo Research Centre in communicating research results was mentioned, as was the World Heritage Committee, once it is formed. The importance of personal contact, the community notice board, informal get-togethers and building relationships between researchers and community members were also noted. Other suggestions made for improving research uptake included: having regional people sit on the research management coordination committee, basing someone in the region, and providing resources for integrating research with events and activities in the region.

Overall, it appeared the NRP models had not been taken up to the extent hoped. It was suggested that although the model training was a good effort, ultimately the model is too complicated for non-specialists to use, and that the biggest value of the training was the bringing together of different groups. One of the scientists indicated that six months after the training, they still had not received a request from anyone to use their model. It was likewise noted that despite a positive reception by agencies in Perth, no follow-up requests had yet been received. On the positive side, it was noted that applications have been submitted for projects that will use the models if funded. One locally-based interviewee felt using real local projects for the model training would have had more impact and created more local ownership and initiative for their continued use. Another locally-based stakeholder indicated that they felt the models would be used by the Shire for proactive planning and managing growth. The importance of finding a custodian for the models with the closing of the NSDO was noted, as well as the need for keeping the models up to date. Other suggestions included using a smaller stakeholder group, using simpler models, and educating
stakeholders about using models in phases, in the context of complex systems and adaptive management.

Opinions on the stakeholder engagement process were largely positive, although there were a couple of negative comments. Some of the interviewees made comments about the first round of compiled stakeholder interviews, noting that the interview results helped them understand the perspectives of other groups. One interviewee noted that they felt stakeholder communications were excellent particularly with Beth and Tod. On the other hand, another interviewee felt there was very little return for engaging with researchers and was still waiting to receive promised copies of final reports. Most of the suggestions related to engaging stakeholders earlier in the process. Recommendations included creating ‘tribe’ at the beginning of the research program, involving locals in research from the start, hosting scientists in the community (rather than hotels etc.), more informal contact between researchers and locals, identifying community leaders/champions, and creating personal relationships/standing in the community.

With respect to the Regional Reference Group, views were mixed. One of the locally-based stakeholders believed it had little impact, and another felt it did not work in practice, that it was all talk and no action and a bad use of commercial time. Others felt that the group had considerable value, particularly in terms of networking between groups and bringing people together in face-to-face communication. It was commented that the group had been an important forum for informal discussion between agencies, one which did not otherwise exist in the community, and that it helped dissolve some of the distrust between local organisations. It was also noted that it would have been more appropriate if the reference group was run by a local agency and coordinated by someone from within the community (rather than myself). Another noted that the group should have had a clear mandate, jurisdiction and funding before it commenced.

Views were also mixed on the value of the research coordinator. Some locally-based interviewees felt they did not see much result from the coordinator position, in terms of liaising with and getting information out to stakeholders. Others felt that the coordinator played an important role in presenting the program’s research at the Whale Shark Festival and in developing grant applications for community monitoring etc. Concerns were also expressed about the long delay in releasing funding for the coordinator position, and lack of planning and resourcing for the position and the reference group. Interviewees made a number of suggestions for next steps including: hosting ongoing meetings between regional heads of agencies, making presentations at Shire community information sessions, organising a follow-up symposium in the region, highlighting knowledge transfer challenges in my thesis, and continuing to present information and engage with community.

4.7.2.2 Can you see other applications for this process?

Interviewees felt that a similar stakeholder engagement process could have a number of other applications. These included: sustainable development projects, regionally and nationally; World Heritage and parks planning; regional planning; keeping the community up to date on agency activities; and facilitating researcher and stakeholder involvement in the Ningaloo Research Centre.

4.7.2.3 Thoughts on the knowledge brokering role

Interviewees made several comments about their thoughts on my role as a knowledge broker. Although I emphasised that I wanted critical feedback as well as positive, undoubtedly my asking this question biased the responses to some degree. A number of interviewees indicated that my activities were valuable in connecting community people and researchers, facilitating relationships, providing a point of contact, and connecting researchers with local concerns. It was also noted that I played a role in drawing regional stakeholders together and helping establish mutual understanding between groups. It was suggested that it is important to have someone actively fostering these connections. Interviewees also noted that while contact had dropped off between stakeholders after I left, relationships had persisted, although on a less formal and more irregular basis.
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In addition, it was also noted that I had played a role in driving action, influencing how meetings and presentations were run and information communicated, and generating interest and getting people to ask new questions for the models. Some interviewees also commented that I had helped ensure that regional input was considered in the NRP communication’s plan and that I provided regional context in the monthly management coordination committee meetings.

One interviewee indicated that they valued the time I spent explaining the research and that I had helped “open their eyes” to what was happening in the region. Another noted that I had helped researchers tap into local information networks when doing their promotions.

These results support the literature in Chapter 3 indicating that knowledge brokering is a means of building relationships between people, identifying knowledge gaps, ensuring research is relevant, transforming issues into research questions, and providing opportunities for stakeholders to be involved in the research process. As such, my knowledge brokering can be seen to contribute to the adaptive capacity of the region by helping build relationships between stakeholder groups. However, in terms of actual application of research, no effect was noted in these interview results.

Interviewees also raised a number of issues and concerns associated with my activities in the region. These included poor handling of agency sensitivities, particularly around the formation of the Regional Reference Group, stepping on some agency toes, and inadequate communication with agencies’ headquarter staff in Perth. It was also noted that my operating without mandate created concern, and that there was some distrust among agencies as to my motives. Additionally, one interviewee noted that action research, the basis of my study design, is a foreign concept to biophysical scientists, so they did not understand why I was getting involved in the system I was researching.

Interviewees were also asked to identify both positive and negative attributes I brought to the knowledge-brokering role. Positive attributes included:

- Outgoing personality
- Knowledgeable
- Professional
- Neutral outsider
- Well connected and available
- Social science background
- Strong communication skills
- Willingness to share knowledge
- Relevant qualifications & skills
- Able to work with people
- Listening skills
- Caring about region
- Genuine
- Fitting in with locals

Negative attributes included:

- Lack of political sensitivity/bluntness
- Over-assertive as a PhD student
- Not a member of the community or employee of local agency

These noted attributes are consistent with those identified for knowledge brokers in Box 3.1 of Chapter 3.
Summary & Conclusions

This action research study looked at the application of an emergent knowledge brokering approach to fostering knowledge transfer in the Ningaloo region. This involved embedding myself in the Ningaloo region for 18 months. I adopted the role of a knowledge broker and began actively engaging and collaborating with stakeholders (including researchers) to foster knowledge transfer. Firstly, I interviewed stakeholders to gather their thoughts around the barriers and opportunities associated with knowledge transfer, as well as their knowledge about the socio-political context of the region and the agencies working there. These results were largely consistent with conceptual framework and supporting literature outlined in Chapter 3. I compiled the interview results in a document and shared it with the interviewees and the NRP’s management coordination committee. These results helped inform their and my subsequent knowledge transfer efforts in the region.

Secondly, I used the knowledge and relationships cultivated during the interviews to help catalyse new connections in the Ningaloo system by match-making researchers with managers, and to enter into collaborations with both researchers and local stakeholders groups. Thirdly, as new patterns of interaction began to emerge between different people and agencies in the region, I collaborated with researchers and managers to foster emerging behaviours that enhanced research uptake (e.g., new institutional arrangements, capacity building activities) and to mitigate inhibiting behaviours that resisted these changes. These inhibiting behaviours were consistent with the barriers associated with building adaptive institutions, as identified in the literature reviewed in Chapter 1. In the final stage of the study, I interviewed stakeholders (including researchers) to evaluate how they had been affected by the knowledge transfer process, the types of knowledge generated and shared, and the overall effectiveness of the knowledge transfer process.

The conceptual framework outlined in Chapter 3 is premised on literature arguing that knowledge transfer is more likely to result in practice change when relationships are established between researchers and research recipients. The evaluation interviews supported this conceptual framework as far as indicating that the knowledge transfer process (and my knowledge brokering role) had the two-fold effect of 1) catalysing relationships between stakeholder groups in the region, and between regional stakeholders and scientists—thereby theoretically helping improve adaptive capacity of the region; and 2) improving the usefulness of the research in terms salience, credibility and legitimacy. However, the knowledge transfer process seemed to have little effect on the representational knowledge of local stakeholders, or on the actual application of research in practice—thus in these aspects the conceptual framework does not hold up. In accordance to Roux et al. (2006), the knowledge transfer process appears to have largely failed, despite considerable investment in stakeholder engagement on the part of the modelling researchers, accommodations made by the NRP’s management coordination committee, and 18 months of knowledge brokering effort on my part. This result is consistent with the literature review in Chapter 1, whereby authors indicate that knowledge transfer is rarely successful in practice (Easterby-Smith et al. 2008; Roux et al. 2006), as is likewise the case with attempts to change organisational behaviour (Burnes 2005; Senge et al. 1999).

Based on the literature reviewed thus far, the lack of research application can possibly be attributed to the researchers undertaking most of the stakeholder engagement at the end of the research process (i.e., co-opting and consulting), rather than consistently engaging and involving regional stakeholders throughout the entire research process (i.e., co-learning), as is required for social learning (Pahl-Wostl et al. 2008; Tábara & Pahl-Wostl 2007), research for development (Ashby 2003), and extension (Röling 1988). In these approaches knowledge is co-produced by scientists and managers/local people. As depicted in Figure 3.2, the level of stakeholder commitment to an initiative is proportional to the level stakeholders are involved in it (Gardner 2001b; Quirke 1996). The lack of research uptake may also be because the knowledge transfer process was not integrated with any kind of participatory decision-making forums, as is required in social learning, thereby denying it a plausible vehicle for implementation.

However, as outlined by Watzlawick et al. (2011) in Chapter 1, seemingly intractable problems, such as that of research application, cannot be solved using the rules and premises that govern the system in which the problem is situated. Furthermore, often the strategies that are being applied to
solve problems unintentionally perpetuate or worsen it. This being the case, one must ask whether knowledge transfer is itself part of the research uptake problem. If it is, then no amount of adjusting or increasing knowledge transfer activity will resolve the problem.

As per Watzlawick et al.'s principles of problem formulation, in order to determine whether or not the concept of knowledge transfer is problematic as a strategy for improving research application in decision-making, Western society’s sub-conscious philosophical assumptions around knowledge and the nature of reality must first be examined. If they are found to be wanting, then a new set of premises and new ways of thinking are needed to reframe the problem. This is the purpose of the theoretical exploration presented in Part III of this thesis.
In old China someone gave the Governor a rare fan made of rhinoceros horn—an expensive, useless object. The Governor handed it off to the local Zen master and it was forgotten. One day, the Zen master remembered it and asked, “Bring me the rhinoceros fan.” “Umm, it’s broken,” said the secretary. “In that case, bring me the rhinoceros.”

--Tennant (2005)

Here comes the rhinoceros.
In Part II of this thesis, I outlined how action research testing my initial conceptual framework—that knowledge transfer would likely be more successful if it involved significant stakeholder engagement and relationship building between researchers and research recipients—failed to produce anticipated results, that being an increase in stakeholder (representational) knowledge and application of research and modelling tools.

This failure prompted me to go back to the ‘theoretical drawing board’ and re-evaluate my study in a different context. Watzlawick et al.’s (2011) principles of problem formulation specify that the first step in resolving seemingly intractable problems, such as that of knowledge transfer, require examining the deep assumptions that underpin our thinking about the problem situation. This is the function of philosophy. To this end, I conducted an exploratory review of relevant topics in the history of Western science, philosophy and mathematics, to surface my own underlying assumptions, and those which underpin the field of environmental management (see Appendix 1). The second step involves opening our minds to alternative ways of thinking, and assessing and revising our assumptions accordingly. To do so, I also explored a selection of relevant concepts in mathematical logic, the complexity sciences and the social sciences (see Appendices 2, 3 and 4 respectively).

In Part III of this thesis, I synthesise these reviews for the theoretical investigation component of this study. Firstly I identify the underlying assumptions and philosophies of the Newtonian paradigm that currently dominates Western thinking, then synthesise an alternative complexity-based paradigm (Chapter 5). Then I discuss the phenomena of cognition, learning, knowledge and organising in relation to how they have been understood within the Newtonian paradigm, and present new insights into how they can be alternately understood from the perspective of a complexity-based paradigm (Chapter 6).

The third step in resolving stubborn problems involves reframing the problem according to our new set of premises and assumptions. To this end, I examine the implications of these insights and revised assumptions for environmental management by identifying the limits of reductionist
science, reframing adaptive capacity and the problem of knowledge transfer, and re-framing the outcomes of the Ningaloo action research study (Chapter 7). I conclude by reconceptualising knowledge transfer, reformulating the problem of research uptake, and suggesting a new suite of possible solutions.
Chapter 5

Chapter 5

SURFACING & REVISING OUR ASSUMPTIONS – APPLYING A COMPLEXITY BASED PARADIGM

Caminante, son tus huellas
el camino, y nada más;
caminante, no hay camino,
se hace camino al andar.
Al andar se hace camino,
y al volver la vista atrás
se ve la senda que nunca
se ha de pisar.
Caminante, no hay camino,
sino estelas en la mar.
—Machado (1912)

(Wanderer, your footstep are
the road, and nothing more;
wanderer, there is no road,
the road is made by walking.
By walking one makes the road,
and upon glancing behind
one sees the path
that never will be trod again.
Wanderer, there is no road-
Only foam trails on the sea.)

5.1 Introduction

“What is your aim in philosophy? —to show the fly the way out of the fly-bottle.”
—Wittgenstein (1958)

The first step in Watzlawick et al.’s (2001) principles of problem formulation involves surfacing the deep assumptions that underlie our thinking around the problem at hand—in this case the problem of knowledge transfer and research application. This is the basic function of philosophy and the purpose of this chapter. Metaphysics is a branch of philosophy that concerns itself with investigating the nature of reality and what is ultimately ‘real’ (Craig 1998), its central branch being ontology, which examines questions of ‘being’ (i.e. existence) and what types of things exist (Craig 1998). Epistemology is a branch of philosophy that “investigates how we can know and reason about that reality” (Heylighen et al. 2007); it asks what is knowledge, how is it acquired, and to what extent can a thing or a phenomena be known? Lorimer (2013) points out that despite modern science having evolved from a series of centuries-old metaphysical and epistemological assumptions, today’s scientists rarely concern themselves with epistemology or metaphysics, quoting Willis Harman who said “epistemology is to scientists what ornithology is to birds!” But if

32 Van Inwagen (2007) notes that metaphysics is “notoriously hard to define”—its definition has shifted over time and is the source of much scholarly contention.

33 In the 17th century, as the term ‘ontology’ came into use, metaphysics became something of a ‘catch-all’ category; Wolff responded by breaking metaphysics down into ‘general metaphysics’—the study of being as such, or ‘ontology’, and ‘special metaphysics’—the study of particular types of being, e.g. material, spiritual, etc. (van Inwagen 2007). Since then metaphysics has often viewed as synonymous with ontology. The Routledge Volume of Science, Logic and Mathematics in the 20th Century states “the relation between METAPHYSICS and ontology is unclear…simply put ‘ontological’ means ‘having to do with existence’” (Shanker 1996).
one follows the logic of Einstein, Godel and Watzlawick et al., this is a perilous situation. Failure to recognize the core assumptions that frame how they think about the world renders scientists (and society in general) vulnerable to committing fundamental errors when attempting to formulate and resolve today’s intractable and wicked problems, errors which will be shown in the chapters that follow to lead to vicious circles and exacerbation of the very problems we are trying to solve (as per Bateson 2000; Watzlawick et al. 2011).

The importance of becoming aware of the assumptions that govern our behaviour is highlighted by an example from mathematical game theory showing that “if a person comes to ‘know’ a theory about his behaviour, he is no longer bound by it but becomes free to disobey it” (Howard, 1971, in Watzlawick et al. 2011, p.98). Without such awareness, our problem-solving abilities are caged by the paradigms within which we currently operate (see: Kuhn 1962; Shotter 1994), similar to the two-dimensional creatures inhabiting Abbott’s (2011) satirical Flatland, who, even when confronted by an actual three-dimensional being (empirical proof!), cannot comprehend the notion of three-dimensional space. This is because their thinking is confined by an unassailable belief that the world is made up of only two dimensions (based on the collective weight of their past empirical observations). In the words of Einstein35 (1949), “Science without epistemology is—in so far as it is thinkable at all—primitive and muddled” (p.684). The wisdom of being sceptical of underlying assumptions was embodied in the brilliant mathematician Henri Poincare, who, rather than working from pre-established principles as do most mathematicians, started from scratch in all his work (O’Connor & Roberston 2003).

Becoming aware of our underlying assumptions first requires an understanding of the history of Western science, philosophy and mathematics (with a specific focus on topics relevant to this study), the shifting nature of their underpinning assumptions, and how they have entwined and mutually shaped each other since the times of the ancient Greeks. For readers unfamiliar with this history, an overview is presented in Appendix 1. As per Foucault’s (1980) notions of power being exercised through discourse, the history of science and philosophy can be viewed as an ideological competition to control metaphysical discourse over the ‘true’ nature of reality. Since the dawn of the scientific revolution, this competition has created debate between materialists and idealists, the empiricists and rationalists, Kantian philosophers and the logical positivists, and, more recently, between modern positivists and postmodernists. The quantum physicist Rovelli (2003) attributes this “tortuous historical evolution” to modern science’s “curious schizophrenic attitude of being anti-realist with electrons and iron realist with chairs” (p.28). This entangled path has led to today’s domination of the Newtonian paradigm over other modes of Western thought.

As such, the history of western science is characterised by a tension and competition between the study of substance (what is it made of?) and the study of form (what is its pattern?) (Capra 1997). For centuries the worldview underlying science was largely materialist and Newtonian, with corresponding philosophies of reductionism, mechanism and modernism (Heylighen et al. 2007). Ontologically, this worldview reduces everything to movements of independent material particles governed by deterministic laws (i.e. atomism). Epistemologically it holds promise of complete, objective and certain knowledge of past and future (Heylighen et al. 2007). The Newtonian focus on ‘being’, substance and order led to the creation of the scientific method and revolutionised the world. As such, the study of pattern was eclipsed by the study of substance until 20th century advances in systems theory, relativity, quantum mechanics, non-linear dynamics, chaos and complexity exploded many of the Newtonian paradigm’s core assumptions, sparking a forceful revival of pattern and a return to more ancient (and more Eastern) philosophical roots (Capra 1997). Specifically, the 20th century saw a number of pivotal scientific developments which are now becoming integrated under the banner of complexity sciences, including: Heisenberg’s uncertainty principle, chaos in non-linear dynamics, and a scientific foundation for holism and emergence via systems theory and theories of self-organisation (Heylighen et al. 2007). It also saw two of the most

34 Rittel & Webber (1973) note, however, that there is no definitive formulation of a wicked problem, and no right or wrong solutions (just subjectively better or worse from the perspective of different stakeholders). The solution to the problem depends on how the problem is formulated.

35 Conversely, Einstein (1949) also noted that epistemology without science is an “empty scheme” (p.684). He believed that epistemology and science are dependent on each other.
Influential philosophical works of the 20th century devoted to the shift from ‘being’ toward ‘becoming’³⁶, Whitehead’s *Process and Reality*, and Heidegger’s *Being and Time* (Prigogine & Stengers, 1984).

In this chapter, I will synthesize literature which questions the underlying Newtonian assumptions and philosophies that informed this study’s approach at its outset, drawing largely on the works of Capra (1997), Bateson (2000), Heylighen et al. (2007), and Prigogine and Stengers (1984). I will then propose instead a complexity-based ontology and epistemology (i.e., paradigm) based on a synthesis of the Whitehead’s process philosophy, mathematical logic, quantum theory, general systems theory and the complexity sciences. For this, I draw largely on Capra (2010), Briggs and Peat (1989), Richardson (2005), and Prigogine and Stengers (1984). Appendices 1, 2 and 3 should be referred to for detail and background on these topics. In the chapters that follow, I will then use this proposed complexity-based paradigm to re-examine the nature of cognition, learning, knowledge and organisational behaviour, the role of science and knowledge transfer, and the design and outcomes of the Ningaloo action research study.

### 5.2 Surfacing & Revising Our Assumptions

*"The only thing that interferes with my learning is my education."*

— Albert Einstein

#### 5.2.1 Newtonian Ontology

The dominance of Newtonian thinking has had the effect of subconsciously imbuing western minds with a ‘watch maker’ view of nature and belief in a mechanical universe governed by linear mathematical laws (Capra 1997). Believing that the world consists of a collection of discrete things or entities governed by immutable laws has led to the following fundamental assumptions, which continue to influence how we perceive reality and knowledge. The origins of these assumptions are indicated in brackets. They were largely formulated in ancient Greek times, then elaborated on during Europe’s 17th century scientific revolution, as outlined in Appendix 1:

- Reality consists of separate material things separated by void (5th century BC atomism, 17th century materialism);
- A separate external reality exists independently from ourselves: objective, neutral observation is possible (17th century materialism, empiricism);
- The mind is a material epiphenomenon of upward causation (17th century materialism), or a separate God-given non-material entity (17th century Cartesian dualism);
- The universe is governed by ‘laws’ that somehow pre-date its formation—fixed rules exist in the universe (3rd century BC Plato, 17th century Newton);
- All phenomena are the consequence of upward causation, cause-and-effect—with complete knowledge we can predict and control events (5th century BC Atomists, 3rd century BC Aristotle, 17th century Newton);
- The universe is deterministic—time is reversible, therefore all things can be disassembled and reassembled (17th century determinism, Descartes, Newton);
- Instability/change is caused by external disturbance (17th century Newton);
- Phenomena are linear in nature—the whole is equal to the sum of the parts, so small disturbances create small changes, and big disturbances create big changes (17th century Newton);
- All phenomena can be understood by deconstructing them into their component parts (17th century Cartesian reductionism, Newton).

In a Newtonian universe, a system evolves as its elementary particles (atoms) move about, but there is no way for these particles to merge, disappear or divide. Everything (i.e., matter) that presently exists has always existed and will always exist, albeit in different configurations (Heylighen *et al.*

³⁶ The concept of ‘becoming’ predates these authors, having also been presented by earlier philosophers, such as Hegel (18-19th century) and Heraclitus (500 BC).
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2007), moving around inside an inert container of space and time in accordance with universal rules and laws that pre-date the universe. As such, there is no true novelty or creation (Prigogine & Stengers 1984), just rearrangement of matter through cause-and-effect. Any given state of the system is the inevitable cause-and-effect result of conditions in its prior state, and is therefore predicable given sufficient information. In other words, all phenomena, including ourselves and our minds, are equal to the sum of their parts (Heylighen et al. 2007). Chaos, creativity, wholeness and the flow of reality have no place in this worldview.

These assumptions form the Western ‘map’ of how the universe works, and the platform of a Newtonian ontology that has underpinned science and Western views for centuries. Metaphysically, everything is reduced to the movements of independent material particles governed by the deterministic laws of cause-and-effect.

5.2.2 The Map versus the Territory

"As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality."

—Albert Einstein

Although physics and the complexity sciences moved past the limits of Newtonian thinking long ago, the influence of Newtonian mechanics, with its comparative simplicity and intuitive appeal, has been so pervasive that most people today still equate scientific thinking with Newtonian thinking (Heylighen et al. 2007). Indeed, despite idealist and postmodern influences in many areas of the arts and social sciences, other disciplines, including biology, psychology and economics, have adopted core elements of Newtonian science and methodologies (Heylighen et al. 2007), many of which are still taught in schools today. As such, the material view of the universe as a machine, or a complicated clockwork mechanism, continues to dominate the modern Western era (Capra 1997).

Meppem and Bourke (1999) argue that the present domination of Newtonian ways of thinking and knowing in Western society have contributed to our present sustainability crisis. Quantum and complexity theories (see Appendices 1 and 3) present the opportunity for devising an alternative paradigm for explaining reality, one more in line with idealist and pan-psycho-spiritual philosophies that view reality as a subjective and immaterial whole. Yet how do we know which paradigm is the ‘truest’ depiction of reality? Indeed, Western philosophy still struggles to resolve this dualistic view of reality. According to Naik (2012) “The reality divide continues to lurk beneath our educational and pedagogical systems, and we are unconsciously schooled in its ways of thinking.”

Polish philosopher and scientist Alfred Korzybski is famed for his dictum “the map is not the territory” (1958), which refers to his observation that many people confuse the representation or abstraction of an object with the object itself. The Theory of Logical Types37 (Whitehead & Russell 1913, see Appendix 2) demonstrates how system wholes are qualitatively (logically) different from their parts, and how paradox is generated when logical levels of phenomena are confused. Thus, when people confuse the map with the territory they are making an error in logical typing; in so doing they open the door for paradox (Bateson 2000) as we will see in the chapters that follow. Bateson (2000) applies a Kantian twist to Korzybski’s allegory, arguing that it is impossible to truly know what territory, or reality, is:

We say the map is different from the territory. But what is the territory? Operationally, somebody went out with a retina or a measuring stick and made representations which were then put on paper. What is on the paper map is a representation of what was in the retinal representation of the man who made the map; and as you push the question back,

37 The Theory of Logical Types (Whitehead & Russell 1913) starts with the idea of a collection (or a class) consisting of ‘things’ (or members) united by a common characteristic. According to the theory, whatever involves all of a collection (i.e. a class) must be a member of the collection, as they are of different logical types, or levels. As such, any attempt to deal with one in terms of the other, i.e. confusing logical types, will lead to “nonsense and confusion” (Watzlawick et al. 2011, p.8). Errors in logical typing normally occur either because a particular property has been incorrectly ascribed to a class instead of a member (or vice-versa), or by treating class and member as if they were on the same level of abstraction (Watzlawick et al. 2011). Such errors result in paradox and vicious circles (see Appendix 4, Section A4.4.3).
what you find is an infinite regress, an infinite series of maps. The territory never gets in at all…Always, the process of representation will filter it out so that the mental world is only maps of maps, ad infinitum. (pp. 460-461)

Thus, all our descriptions of reality necessarily involve a level of abstraction and reduction (i.e. they cannot describe its entirety in full), and therefore can never be more than ‘maps’: we can never ‘truly’ know reality. Attempting to invoke ‘truth’ as the goal of science (or religion, or any other ideology) is therefore a fruitless diversion (see Funtowicz & Ravetz 1993; Ravetz 2002), and the wild goose chase of the sustainability debate (see Meppem & Bourke 1999). The absurdity of attempting to do so is illustrated in Borges’ (1998) On Exactitude in Science (written as a literary forgery).

…In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province. In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that that vast Map was Useless, and not without some Pitilessness was it, that they delivered it up to the Inclemencies of Sun and Winters. In the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars; in all the Land there is no other Relic of the Disciplines of Geography.

—Suarez Miranda, Viajes de varones prudentes, Libro IV, Cap. XLV, Lerida, 1658 (p.325)

Nonetheless, ‘maps’ serve an important function: isolating certain signals from a ‘territory’ (i.e. reality), so we can navigate without being overwhelmed by its complexity. For example, in the case of actual (rather than metaphoric) maps, one might show topography, another might show roads. Neither are wrong; rather, both reflect different aspects of the same reality and are more or less useful depending on how you are attempting to cross the territory, e.g. by car or by foot. Likewise Aboriginal Australians created verbal representations of territory using mythological metaphors in songs (Molnar & Meadows 2001), whereas Europeans did so spatially using paper maps—both approaches are useful for getting from A to B across the same territory. Aboriginal Australians also had a way of looking at the night sky that contrasted to that of Europeans, often naming the dark spaces between the stars (e.g. the Emu in the Sky) to present a different view of the same cosmos (Norris & Hamacher 2010). But perhaps the most illuminating example of the mind vs. map metaphor comes from science, in the quantum discovery that photons present as either waves or particles, depending on what the observer decides to measure. Thus, Heisenberg’s statement “What we observe is not nature itself, but nature exposed to our method of questioning” (Heisenberg 1958, p. 81), recapitulates the notion that our observations can only ever be maps, abstracted representations, and never reality itself.

5.2.3 Paradoxical Janus-face of Reality

“For even rationality cannot get by without imagination, but neither can imagination without rationality. The marriage of the two is, however, of such a peculiar kind, that they carry on a life and death struggle, and yet it is only together that they are able to accomplish their greatest feats”

—Korff (1923)

The co-evolution of Western philosophy, science and mathematics, as detailed in Appendix 1, is characterised by the cyclical emergence and subsidence of opposing theories about the nature of reality: mind versus matter, materialism versus idealism, form (or pattern) versus substance, determinism versus free will, upward versus downward causation, whole versus the parts, quantity versus quality, and order versus chaos. Over and over these same themes have popped up in different guises and in different arenas. At times these themes have mutually reinforced each other, at others broken each other down, in an oscillating dynamic of entwined ideological creation and destruction, played out through history like an epic game of ‘whack-a-mole’.
For example, the idea of matter being atomic was first devised by ancient Greek philosophers, shot down by Socratic philosophers, briefly revived by the Epicureans, then, two thousand years later, taken up in the scientific theories of Galileo and Newton. The importance placed on the role of pattern, organising relations and emergence in shaping reality has likewise emerged and subsided through history. These ideas were postulated by the Pythagoreans of 500 BC, fell away during Socratic times, then were revived by German idealist philosophers of the 18th century. They were later ‘proved’ by mathematical logicians of the 19th and early 20th centuries (as detailed in Appendix 2), and taken up by organicist biologists, holists, process philosophers and quantum physicists of the early 20th century.

Nobel Prize laureate Ilya Prigogine (Prigogine & Stengers 1984) states that astonishing success of science has led to a “collision between what has often been called the ‘two cultures,’ science and the humanities,” and has led to the repeated question “How to choose?” (p.11). But according to Alfred Whitehead, a clash of doctrines is an opportunity not a disaster (Prigogine & Stengers 1984). Galois’s mathematical Group Theory, and Watzlawick’s psychological theory on orders of change, show how opposites combine to reinforce the identity or pattern of the group to which they both belong (see Appendix 2, and Appendix 4, Section A4.4.3 respectively). This phenomenon was likewise recognised in ancient times by Heraclitus, who purported that all entities come into being through a tension between opposing properties.

These observations, common to math, science and ancient philosophy, indicate that the competing themes that repeatedly emerge, subside and remerge in Western metaphysics are not actually conflicting. Rather, they are elements of a singular, higher order phenomenon, just as Newton’s absolute space and time were revealed as unified in the fourth dimension by Einstein (Figure 5.1; see also Appendix 1, Section A1.5.3). As such, these themes are glimpses of reality’s paradoxical ‘Janus-face’ illuminated from different angles.

Figure 5.1. A donut ring incised by a plane, viewed first in two dimensions then in three, depicting of how two seemingly unrelated phenomena are revealed as parts of a whole when put into the context of a higher dimension (adapted from: Capra 2010).
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5.2.4 The Power of Maps

“Reality is what we take to be true. What we take to be true is what we believe. What we believe is based upon our perceptions. What we perceive depends on what we look for. What we look for depends on what we think. What we think depends on what we perceive. What we perceived determines what we believe. What we believe determines what we take to be true.”

—David Bohm (1977)

Thus the material Newtonian paradigm and the immaterial idealist/panpsychic paradigm can be seen as two sides of the same coin. They, along with other paradigms, are different ‘maps’ attempting to explain the same ‘territory’. This reflects Rose’s (2003) notion that for any living phenomenon, there are many possible explanations or descriptions. Yet maps are much more powerful than they seem on the surface, because they do more than just represent reality. Capra (1997) describes how the habitual use of linear approximations to describe non-linear phenomena led many engineers and scientists to believe that decidedly non-linear natural phenomena were actually linear (Appendix 3, Section A3.2.1). In other words, confusing the map with the territory led to subconscious absorption of the assumptions underlying the map. So it happens that through repeated use, maps begin to shape how we perceive reality and therefore how we act into the future. Quantum and chaos theory demonstrate the profound interconnectivity of the universe and the vast, long-range influence even the most minute of actions can have (see Appendices 1 and 3). Because we cannot step outside the system, there is no objective observation. Thus, how we act based on our conceptions of reality, inevitably, and perhaps profoundly, affects the shape of future territory.

For example, Western industrial and post-industrial views of a linear natural world led to assumptions of unlimited energy and raw materials, and an infinite capacity on the part of the environment to absorb waste and pollution. This in turn led to the linear structuring of modern industrial food, energy and water and sanitation systems (Jones et al. 2010), systems which have radically changed the earth’s biosphere and hence the ‘territory’ of our reality. When we confuse the map with the territory, we commit an error in logical typing (see Appendix 2). Consequently, paradoxes and vicious circles inevitably arise (Bateson 2000; Watzlawick et al. 2011), and hence our current global sustainability crisis. Thus maps do not just represent reality, they also shape it through our participation. This is why powerful and vested interests attempt to dominate and control ideological discourse (see Foucault 1980). It is also why surfacing the subconscious maps that shape our assumptions about reality is so important when we face wicked problems.

5.3 Drawing a New Map: a Complexity-based Ontology

"Reality is merely an illusion, albeit a very persistent one."

—Albert Einstein

The 1920s saw a respite from reductionist materialism in science after discoveries in quantum physics revived interest in the holistic philosophies of Kant and Goethe. As outlined in Appendix 1, this notion of metaphysical wholeness became a centerpiece of Whitehead’s process philosophy, Smut’s holism, Alexander’s emergentism, and von Bertalanffy’s general system theory. However, by the time the dust of WWII had settled, these theories, with their panpsychic and idealist leanings, were lost to mainstream science, having succumbed to the purges of the logical positivists and their remnants swallowed by war. Newtonian reductionism made its forceful revival in the scientific realism that came to dominate scientific thinking of the post-war era. Heylighen et al. (2007) suggest that reductionism eclipsed holism because Newtonian approaches were so successful; as a result, it was thought they could explain everything. By comparison, holism had a mystical

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38 And wicked problems being social problems require that those involved in the problem situation collectively surface their assumptions. For example, Meppem (2000) proposes ‘discursive communities’ as a means improving social relations and articulating strategies for sustainable development, via exposing power relations, surfacing “uncontested assumptions regarding the limits and hierarchy of our knowledge claims,” and empowering stakeholders in participatory decision-making (p. 59).
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sensibility that seemed to lack scientific foundation—it pointed to the tendency of wholes to be greater than the sum of their parts, but begged the question: what exactly is it that is ‘more’ in the whole? (Heylighen et al. 2007). Yet despite the spectacular success of reductionist science, which breaks everything down into its simpler parts, it leaves a vacuum in its lop-sidedness:

How do we use the information gleaned from the parts to build up a theory of the whole? The deep difficulty here lies in the fact that the complex whole may exhibit properties that are not readily explained by understanding the parts. (Kauffman 1995, p.vii-viii)

To fill this vacuum a new paradigm is needed, one that ‘gazes upward’ toward the whole, to complement the ‘downward gaze’ of the reductionist Newtonian paradigm with its focus on the parts. As Godel’s Incompleteness Theorem (Appendix 2) implies, because this new paradigm will relate to phenomena of a higher logical order than that which can be explained by the Newtonian paradigm, it will require an entirely new set of premises, and a radically different way of thinking about the world. As outlined in Appendix 3, the complexity sciences can help furnish this paradigm. Heylighen et al. (2007) suggest that complexity theory can help philosophy solve “some of its perennial problems, such as the origins of mind, organization or ethics” (p.118). Prigogine and Stengers (1984) propose that understanding the complexity of reality requires a synthesis of deterministic Newtonian physics and probabilistic quantum physics, one which applies Whitehead’s understanding of reality as interconnected processes rather than as separate things. Similarly, I believe the complexity sciences can provide a theoretical framework that unifies opposing Western ontologies.

In the following sections I will present the features of a proposed complexity-based ontology and epistemology. Together they comprise a complexity-based paradigm that serves as a ‘more complete’ (i.e. holistic) alternative to the ‘lop-sided’ Newtonian paradigm. This proposed ontology synthesises complimentary concepts in math, science and philosophy described in Appendices 1, 2 and 3, namely: Heraclitus’ unity of opposites, mathematical logic, relativity, quantum physics, holism, Whitehead’s process philosophy, general systems theory, chaos theory, non-linear thermodynamics, autopoiesis, and complexity theory. This synthesised ontology is detailed below and compared to that of the Newtonian paradigm.

5.3.1 Immaterial Nature of Reality

In contrast to the Newtonian ontology, in which reality is seen to consist of atomic material, or ‘things’, in this complexity-based ontology reality is seen to consist of immaterial interconnections (Heylighen et al. 2007). As such, reality is better understood as processes rather than things (as per Whitehead & Sherburne 1981). As postulated by quantum theory (Appendix 1, Section A1.5.6), things that appear to be material, such as atoms, are actually just patterns of relationship between things, which themselves consist of interconnected patterns of relationships between other things, and so on (Bohr 1958). Thus atoms and particles are simply abstractions: there are no ‘things’, only interconnections within interconnections (Stapp, in Capra 1997). These interconnections appear to us as solid and material by virtue of scale, but are revealed as immaterial patterns when examined at the quantum level. Time also creates the illusion of a substantial reality—stable patterns of relationship that persist in time also appear to us as substantial entities (Rescher 2008). This quantum perspective is in keeping with autopoiesis (Maturana & Varela 1980) and process philosophy (Whitehead & Sherburne 1981), which likewise postulate that reality has no material foundation. What appear to be substantial are actually processes organising into spatial and temporal patterns—all entities are just units of interaction (Maturana & Varela 1980; Whitehead & Sherburne 1981).

Accordingly, from this point on in my thesis, when the terms entity or system are used they will connote an emerging coherent pattern of immaterial relationships, rather than what they normally signify, which is a configuration or network of substantial things. Likewise, when the term agent it used, it will be understood as a sub-pattern of coherent relationships that is subordinate to a higher order unifying pattern. This approach is consistent with that Checkland et al.’s (1981) soft systems methodology, which treats systems as epistemological entities
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(i.e. symbolic mental representations of something experienced in reality, or ‘maps’), rather than as ontological entities (i.e. actual things, or ‘territory’).

5.3.2 Interconnected Whole

Whereas the Newtonian paradigm views reality as consisting of isolated material particles separated by void, quantum theory indicates that reality is in fact a “complicated web of relations between various parts of a unified whole” (Capra 1997, p.30). Apparent particles are not isolated ‘things’, and, as stated by Bohr (1958, p. 57), “Isolated material particles are abstractions, their properties being definable and observable only through their interactions with other systems.” [italics added]. This brings to mind Heraclitus’ unity of opposites, which supposes that all things are brought into being by opposition between conflicting properties.

5.3.3 Observer Dependence and Participation

In the Newtonian paradigm, a separate external reality exists independently from ourselves. As such, objective, neutral observation of reality is possible. However the vast interconnectedness and wholeness of reality has been revealed by quantum theory (Bohm 2012; Capra 1997), which shows that observing a system changes a system (Heisenberg 1930). This interconnectedness is also a feature of chaos theory, which demonstrates the extreme sensitivity dynamic systems have to initial conditions, due to bifurcations caused by amplification of small events (Briggs & Peat 1989). As such, the scientific ideal whereby an observer occupies a privileged, objective position outside a system is impossible. The universe is hence a “participatory universe” (Wheeler, in Capra 2010, p.141), and both reality and our experience of it are necessarily shaped by how we observe it, an idea which echoes Kant’s transcendental idealism. Indeed, notions of subjective versus objective reality are meaningless: ultimately there is no outside or inside (Maturana & Varela 1992) because all entities are processes interconnected within the tissue of reality. Indeed, there are no truly closed systems other than the entirety of the universe.

5.3.4 Predictability and the Arrow of Time

In the Newtonian paradigm, reality is deterministic, the inevitable result of cause-and-effect (upward causality), unfolding in accordance with immutable laws that somehow predate the universe’s existence. In this view, the arrow of time and hence all processes are theoretically reversible. Once the first kernel of the universe is set into motion, true novelty is no longer possible (Prigogine & Stengers 1984, Briggs & Peat 1989). With sufficient knowledge about the state of a system, we can accurately predict its future states, and back-cast to know its past states as well (Capra 2010).

However, entropy in closed systems and the complexity that spontaneously emerges in open dissipative systems indicate that there is indeed an arrow of time, that the processes emerging from self-organising interactions of multiple entities (i.e. subsystems, or agents) in an open system are irreversible (Prigogine & Stengers 1984). As such, change can be a causal, as is also demonstrated by bifurcation points in chaos theory (Briggs & Peat 1989). Open systems far from equilibrium become increasingly and irreducibly complex over time, as per dissipative structures and non-linear thermodynamics, whereas closed systems near equilibrium become more irreversibly disordered, as per classical thermodynamics (Prigogine & Stengers 1984).

5.3.5 Self Organisation

As such, from the perspective of a complexity-based ontology, reality is continuously creating itself—dynamically emerging from the creative interactions of the entities that comprise it. In other words, the universe is being co-created at every moment through a process of action and reaction. Entities (which themselves are just nested patterns of interaction) perpetually interact to co-evolve and co-create reality, bringing forth the future, as per Whitehead’s process philosophy (1981), Maturana and Varela’s autopoiesis (1990), and Kauffman’s notion of fitness landscapes (1993). As such, each new moment is novel, inevitably different from the previous (Whitehead & Sherburne 1981). This resonates with Heraclitus’ notion of the ever-changing flow of reality, and his dictum that “you can never step in the same river twice”. It also relates back to quantum theory’s observer
dependence and Wheeler's notion of a participatory universe (as cited in Capra 2010). We participate in the universe's co-creation at every moment through the process of our relating, the effects of which ripple through the web of existence.

These ideas point to the notion that spacetime could be a four-dimensional higher order phenomenon that somehow emerges from these dynamically emerging creative interactions39, as is suggested by theories of quantum gravity (Wuthrich 2010), and Alexander's (1920) theory of Emergentism (see Appendix 1, Sections A1.6.6 and A1.5.4). This is in contrast to the Newtonian view of space and time as an inert backdrop or container for the material universe.

5.3.6 Change versus Creation

This view of reality and the universe as being perpetually constructed, or ‘becoming’, differs subtly but significantly from the Newtonian perspective, which sees the universe as a shifting configuration of matter and energy. In the Newtonian view, change is an alteration in some aspect of the universe’s pre-existing configuration, the result of disturbance from some outside force. However, in this proposed complexity-based ontology, what we perceive as change is actually creation—creation of a new moment that differs from the last. If one visualizes ‘flattening’ this perpetually emerging and self-creating universe (by removing the fourth dimension of unified spacetime and thereby dropping down a logical level), the result is a Newtonian universe, where space and time are separate, unrelated entities, operating within the same dimension. This is a case of confusing logical types—assuming unified spacetime is of the same logical level as space. This of course generates paradox, such as the paradox of instantaneous gravitational force (see Appendix 2, Section A2.3).

This ‘flattening’ tendency we have is a by-product of our materialist assumptions about reality, which have been reinforced by our adherence to the Newtonian paradigm. Because of the scale at which our human awareness operates, we cannot ‘see’ the insubstantial nature of matter with our senses. If we could capture and hold moments in time as stacked freeze frames, while simultaneously ‘seeing downward’ through to the quantum scale, we would ‘see’ emerging snapshots of probability clouds of quantum particles (which themselves are just nested patterns of interactions) that constitute what we perceive to be substantial. In doing so, when lifting one of our hands, for instance, instead of understanding it as ‘thing’ changing position, we would ‘see’ it as a ‘growing’ stack of freeze frames of emerging events. These would appear like 3D snapshots or cross-sections of the configuration of quantum particles at each particular point of emergence (Figure 5.2). Stacked together, the freeze frames reveal the pattern of emerging events, the pattern being what creates the sensation of substance. What we see as a substantial hand moving around in space would then be seen as an emerging pattern of quantum relationships. If we remove the dimension of time from our experience, by disconnecting our sensation of the present from the past, we are left with only a spatial configuration of quantum particles, thereby the dissolving the illusion of substantial reality (i.e. pattern) created by our experience of time.

Our grip on time, however, is tenuous at best; we cannot at once hold in our minds the continuous flow (i.e. pattern) of events that precede the present moment. We have only the highly limited and unreliable recall of our diaphanous memories. Another way of gaining a grasp of time as a flow of events is to examine stroboscopic photographs showing patterns of motion. Figure 5.3 shows a stroboscopic image of a bouncing ball. In a normal photo, a bounced ball would appear as a circle suspended in space, and would appear to have only two spatial dimensions. In the stroboscopic photo, however, the dimension of time is captured along with that of 2D space, and thus the

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39 Einstein suggested that spacetime is curved by the presence of matter (like a bowling ball placed on a rubber sheet). But again, this seems to suggest a pre-existing, albeit dynamic and interacting spacetime (see Appendix 1, Section A1.5.3). But if spacetime is emergent, perhaps its curvature is a by-product of the ‘shape’ of reality’s emerging patterns. For instance, larger higher order patterns create large curves, which we perceive as stronger gravity or larger warps in the gravitational field. So in a way, if we flip Einstein’s rubber sheet diagrams upside down, we get a better intuition for what’s happening—gravity isn’t a mysterious field being warped by matter, it is the emerging shape of ‘matter’ (i.e. patterns of interaction). The higher the order of the emerging pattern, the bigger the perceived curve or warp in spacetime/gravity. As such, rather than being ‘real’ or absolute entities, space and time are simply linguistic and mathematical constructs (i.e. maps) we use to describe the emerging shape of reality.
moving ball appears as a more complex 3D spiral\textsuperscript{40}. This image helps us understand how it is that a quantum particle might behave as either a wave or particle, depending on how we observe it. Likewise, by capturing time as well as space, the stroboscopic image of a dancer in motion (Figure 5.4a) creates the impression of an entity growing across the 2D space. In the case of Figure 5.4b, the stroboscopic sculpture of a jumper in motion creates the impression of the entity growing into a 3D space. Our normal perception would be that of the dancer or jumper moving around in space, as opposed to growing into or across it. Thus, if we captured our hand movement as freeze frames at a normal scale—rather than at the quantum scale described in the previous paragraph—the impression wouldn’t be that of one’s hand moving around in space, it would be of a hand growing or flowing into the space. By freezing and capturing events in time as sequential stacked images, the stroboscope effect creates a perceptual jump to a higher logical order. This perceptual jump can help us understand space and time as being unified higher order phenomena, rather than as separate and unrelated lower order phenomena (as per Figure 5.1).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5_2.jpg}
\caption{Figure 5.2. Images\textsuperscript{41} (in 2D and 3D) representing how reality can be thought of as a growing stack of snapshots, or freeze frames, depicting the configuration of quantum particles that comprise emerging events at particular points in time. The patterns of particle configuration through time create the illusion of a substantial reality (sources: Deco et al. 2010; Springel 2013).}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5_3.jpg}
\caption{Figure 5.3. Stroboscopic image of bouncing ball, illustrating how a particle can be understood as either a particle or a wave (source: Davidhazy 2013).}
\end{figure}

\textsuperscript{40} Note how photographic images are ‘flattened’ depictions of reality—the normal photograph of a ball is a two dimensional depiction of a three (spatial) dimensional entity (a ball), and the stroboscopic image is a three dimensional depiction (two spatial dimensions plus the dimension of time) of a four dimensional entity (a ball moving through space).

\textsuperscript{41} Note that these images are not actual depictions of quantum relationships, nor do the publications from which they are derived have anything to do with quantum particles.
Figure 5.4. Stroboscopic images illustrating a shift in perception from that of an object changing position, to that of an object growing across 2D space (a), or into 3D space (b). By capturing the dimension of time with that of space, such images help us make the perceptual ‘jump’ to a higher logical order whereby we can recognise space and time as unified rather than separate phenomena (Davidhazy 2013; Jansen 2013).

5.3.7 Self-creation & Emergent Spacetime

It is often claimed that we cannot really grasp the dimension of time. However, this is not necessarily the case if one simply revises their ontology, from that of a changing and pre-given reality situated within a pre-existing ‘container’ of space and time, to that of an emerging reality from which unified spacetime emerges (spacetime simply being a mental construct we use to describe the scope of emerging reality). In doing so, we view every present moment as a configuration of related events that are the manifestation of a ‘growing’ reality. In addition, the scale at which we experience time causes us to perceive most things as existing and moving around in space, rather than emerging through self-creation. However, if we lived, much, much longer, and our perception of time was radically sped up, before our eyes we would see all things—including animals, trees, forests, mountains, and planets—emerging and growing, then breaking down and disintegrating before rising up again. This would help us understand reality as continuously emerging in a dynamic process of creative destruction, of oscillating order and disorder.

It is also frequently argued that while we can move in any direction within three dimensions, we can only move forward in time, the fourth dimension. Arguments about how it is that we can or cannot move around in space and time are premised on an absolute notion of space and time, whereby they serve as the ‘container’ (or backdrop) in which our universe moves around. This, however, is a false premise, and hence these arguments represent an error in logical typing in our ontology. Einstein’s special relativity (Appendix 1, Section A1.5.3) shows us that space and time are not separate absolute entities. Rather they are unified in the fourth dimension as spacetime. Quantum gravity theories (Appendix 1, Section A1.6.6) suggest that spacetime emerges from reality as it is being created (reflecting Whitehead’s process philosophy, Appendix 1, Section A1.5.5)—hence there is nothing (neither space nor time) for us or the universe to move around in! Space and time are created by our interactions, or, more correctly, they are the scope of our interactions (as they do not exist in an absolute sense). The question of what direction we can move in time is therefore nonsense. This recounts Watzalwick et al.’s principles of problem

42 See Gunderson and Holling’s (2002) concept of panarchy.
formulation, and the difficulties that arise when questions are formulated on the basis of false assumptions (Appendix 4, Section A4.4.3).

The figures from the previous section help illustrate how the Newtonian view of reality can be regarded as a ‘flattened’, or lower order three-dimensional abstraction of a dynamically emerging four-dimensional universe. As such, our adherence to the Newtonian view equates to using a two-dimensional map to describe a three-dimensional territory, then coming to believe that the map is the territory, that the territory is also two-dimensional. Another way of understanding this is by using billiards as a metaphor to visualize a changing universe from the perspective of Newtonian ontology. The billiard table is a two-dimensional representation of the three-dimensional space and time backdrop in which the Newtonian universe is situated. Time is visualised as operating separately but in the same dimension as space (i.e. the plane of the billiard table). The player striking the cue ball represents the mysterious first force that sets universe in motion. The billiard balls, when racked, are the equivalent of the primordial unity that, once struck, explodes into atomic bits of matter (i.e. the Big Bang). As the balls break apart, they represent lumps of matter colliding around in space and time until gradually slowed to a complete stop by friction/entropy.

In contrast, a metaphor for visualising a self-creating universe from a complexity-based ontology would be the inflating cascade of bubbles created when soap is poured into fast flowing water. The bubbles of surface tension created as polarized soap molecules spontaneously align are equivalent to coherent patterns emerging from the self-organizing interactions between opposing entities. The spatial scope of the universe is the equivalent of the two-dimensional area occupied by the bubble mass at a given point, and temporal scope is equivalent to its rising height in the third dimension. As the bubble mass spreads horizontally in the second dimension, it represents emerging space, and as it rises vertically in the third dimension it represents emerging time: together they represent emerging events (space+time). Thus, the growing three-dimensional bubble mass is a lower order representation of emerging four-dimensional spacetime.

5.3.8 A Universe United in the Fourth Dimension

Another important aspect of emergent spacetime is its unifying property, as per Figure 5.1. Our intuition of a unifying four-dimensional spacetime can be developed with the following exercise. Examine the images in Figure 5.5. Image (a) depicts five objects that appear to have no connection—they are separate. Image (b) depicts two objects that likewise appear to have no connection. Nor is there any apparent connection between image (a) and image (b).

![Figure 5.5](sources: Mad Sci Network 2013; U.S. National Library of Medicine 2013)

However, the objects within each image and the two images themselves are in fact connected. It is impossible, however, to discern this connection from the images presented. This is because they are two-dimensional viewpoints of a three-dimensional phenomena—they are of a lower logical order than the whole phenomena of which they are a part. The three dimensional viewpoint of this phenomena is illustrated in Figure 5.6.
Figure 5.6. Two dimensional transverse sections of a human body stacked to reveal a three dimensional whole human, revealing how the items shown in images (a) and (b) are connected (adapted from images sourced from: Mad Sci Network 2013; U.S. National Library of Medicine 2013).

In Figure 5.6, the apparently separate objects depicted in Figure 5.5 are revealed to be connected in the third dimension, by way of being two dimensional transverse sections\(^{43}\) (parts) of a three dimensional human. Because a transverse section is of a lower order dimension \((x,y)\) than the whole human \((x,y,z)\), a whole human cannot be inferred or understood from just looking at a

\(^{43}\) Bear in mind that the transverse sections illustrated in Figure 5.4 are not only slices of space they are also slices of time. If one could observe a living human body in real time from the perspective of a transverse section, one would see tissue and cells dynamically interacting.
transverse section of a human. Nor can it be inferred by simply looking at more transverse sections of human. For example, if, as an observer, one were to:

1) move through the whole human along the z-axis, from top to bottom, but from inside the two dimensional (x,y) perspective, our experience would be one of watching abstract objects moving around and reconfiguring in space, as depicted in this video link http://www.madsci.org/~lynn/VH/transverse.html.

We do not get a meaningful understanding of the whole human until we step out from inside the body, and view the whole human from an outside three-dimensional perspective. Thus, if an observer were to:

2) stand in the third dimension outside the transverse sections and observe them stacking up from feet to head (i.e. introducing height, sequentially from the bottom to the top of the z axis arrow in Figure 5.6) our experience would be one of watching a human emerge from the ground up.

Understanding the whole human requires a jump to a higher dimension/logical order—that of the third dimension (x,y,z). Note that the x, y and z dimensions are not separate unrelated components—they are nested and continuously interrelated aspects of the whole.

The logic from this exercise can then be applied to how we think about space and time vs. spacetime and the universe:

2D transverse section \( (x,y) \) = part of a human \( \rightarrow \) \( z \) (height) \( \rightarrow \) 3D body = whole human \( (x,y,z) \)

Thus,

3D space \( (x,y,z) \) = part of the universe \( \rightarrow \) \( t \) (time) \( \rightarrow \) 4D spacetime \( (x,y,z,t) \) = whole universe

This brings home the notion that four-dimensional spacetime is not a component of the universe—it is the universe: the whole dynamically emerging universe, from its origin to the present moment. Thus, observer experience (1) outlined above would equate to being inside the universe and time-travelling through it, from its beginning to the present; whereas observer experience (2) would equate to standing outside the universe and watching it emerge/self-create, inflating into four dimensions like the cascading bubble mass comparison outlined in the previous section.

Our attempts, therefore, to understand the universe from a Newtonian perspective (which is our every day experience of it) are equivalent to trying to understand a whole human from what we can find in a transverse section of a body (Figure 5.5). The only way of gaining a meaningful understanding of the whole universe is to step outside of it and view it from a unified four dimensional perspective—an act beyond the capacity of our senses, given the logical level at which humans operate in the cosmos.

5.3.9 Irreducibility: The Whole is Greater Than the Sum of its Parts

Understanding system wholes also requires an understanding of system irreducibility. Even though no moment is a perfect replica of the previous, stable probabilistic patterns do emerge in reality when different entities/systems couple together to create feedback loops. In doing so, their interactions harmonise/self-organise to create a higher order pattern of behaviour that unifies the system into a whole (Heylighen et al. 2007). This system whole is greater than the sum of its parts,

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44 Nor could the contents of the transverse section be predicted or understood from looking at the whole human (without dicing him or her up). They are of different logical orders.

45 Richardson (2004) argues that this term is misleading, because 'greater than' connotes a “common measure to compare the whole and its parts and that by this measure the whole is greater than the sum of those parts” (p.76). He believes this wrong, because wholes are qualitatively different from their parts.
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as per holism (Smuts 1927), General Systems Theory (von Bertalanffy 1969), quantum theory (Bohm & Hiley 1993; Heisenberg 1930), Godel’s Incompleteness Theorem (1931), the Theory of Logical Types (Whitehead & Russell 1913), and complexity theory (Kauffman 1993). As such its pattern is also qualitatively different to the patterns governing its subsystems (Richardson 2005)—e.g. the pattern of a human is of a higher order and qualitatively different to the patterns of its organs and cells. Heylighen et al. (2007) use the example of sodium chloride (NaCl)—table salt\(^46\). The essential qualities which define salt—salty, inert, edible and crystalline—are emergent properties, which are qualitatively different from the properties of its component parts: sodium, a volatile soft metal, and chlorine, a poisonous gas. It isn’t the ‘things’ sodium and chloride that give rise to the ‘thing’ salt—it is the relationship between them, which relates to Bohm’s notion of implicate order in quantum theory (2012, see Appendix 1, Section A1.5.6). Thus, the whole always possesses a property or pattern that is not present in its parts, as per the role of missing information in Godel’s Incompleteness Theorem (Appendix 2). As a consequence, because the system whole is greater than the sum of its parts, coupling allows it to explore a greater phase space than would be available to the sum of its component subsystems.

This provides further evidence that the arrow of time is irreversible (as per Prigogine & Stengers 1984), and that a complex system’s behaviour cannot be understood and predicted by simply breaking it down and analysing its component parts (Appendix 3), as per Cartesian reductionism. In sum, each system, or entity, is in essence an irreducible pattern that has spontaneously emerged from the patterns of relationships created by coupling between its component subsystems, one which cannot be described or predicted on the basis of the properties or patterns of its subcomponents, as per the Theory of Logical Types (Appendix 2). For this reason, complex systems are resistant to reductionist analysis requiring some part of the system to be cut off from ‘external’ feedback loops (i.e. holding other parts of the system constant) so it can be examined in isolation (Anderson 1999).

Capra (1997) states that when studying substances we weigh and measure things, whereas patterns cannot be weighed and measured; their configuration of relationships must be mapped. Capra (1997) suggests that most reductionists cannot understand the limits of reductionism because they do not understand the importance of pattern. They believe that because life is made up of the same atoms and molecules as non-living things, the laws of biology can be reduced to that of chemistry and physics. He argues, however, there is something more to life than just substance, “something non-material and irreducible—a pattern of organisation,” (p.81) notably a network pattern. When a living thing is dissected its components are still there but its pattern of relationships is destroyed; it is now dead (Capra 1997). Likewise, as per classical thermodynamics (Appendix 1, Section A1.4.5), when a non-living system is closed, i.e. cut off from relationship with other systems, it eventually succumbs to the forces entropy and ‘winds down’ until it becomes completely disordered—i.e. it essentially dies.

5.3.10 Dynamic Nested Patterns of Relationship

Systems couple with other systems to create a metasystem, from whose interactions (upward causation) a governing metapattern spontaneously emerges, which in turn exerts downward influence (downward causation) on the nested systems that comprise it (Heylighen et al. 2007). Thus, systems coupled into metasystems are constrained by the downward causation exerted by the whole. This means they have to obey the rules of relationship that maintain the coherence (i.e. emergent properties or circular organisation) of the metasystem, and can no longer act independently (Heylighen et al. 2007). In essence, reality is a perpetually emerging dynamic pattern of nested relationships.

The cycle repeats itself when metasystems couple together to create meta-metasystems, and even higher order patterns of circular governance. Richardson (2005) notes that each level or dimension of organisation “exhibits a substantial realism” (p.623), meaning there are “solid representations of

\(^{46}\) Heylighen et al. (2007) also evoke musical pieces to describe emergence. They have properties of melody, rhythm and harmony, which don’t exist in the musical notes that comprise the pieces. The authors suggest that most of life’s important phenomena are emergent: beauty, life, intelligence, status, etc.
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5.3.11 Upward + Downward Causality = Circular Organisation

This dynamic combination of upward and downward causation is equivalent to the autopoietic notion of circular organisation. It is the generator of homeostasis and the hallmark of living systems (Maturana & Varela 1980). Circular organisation can only be established and maintained in open systems where there is a continuous through-flow of material and/or energy (i.e. systems far from equilibrium, as per Prigogine & Stengers 1984). Once established, circular organisation serves to maintain the subsystem interactions that created it (via negative feedback). This involves reinforcing and reproducing the ‘identity’ or cohesion of the system whole by exerting a higher order governing pattern (downward causality) onto its component subsystems such that their interactions continue to reproduce the higher order circular organisation (upward causality) (as per Maturana & Varela 1980, Heylighen et al. 2007). This reflects Heraclitus’ unity of opposites dictum that the ‘the path up and the path down are one in same’ (cited in Capra 1997). It also relates to Heraclitus’ notion of collections: “Collections: wholes and not wholes; brought together, pulled apart; sung in unison, sung in conflict; from all things one and from one all things” (quoted in Daniel 2011).

As such, the system is self-referential, or self-reproducing, and with repeated iterations tends to become increasingly stable and cohesive over time (Maturana & Varela 1980). This is why it is often difficult to change emergent order once it has established. A persistent pattern of relationship creates the sense of a boundary (Richardson 2005), giving it the impression of substance and separateness from the perspective of the observer. Boundaries are thus emergent, temporary, and relative to the scale of observation (Richardson 2005).

Circular organisation is equivalent to the system’s attractor (as per chaos theory, see Briggs & Peat 1989). It is the subset of phase space to which the system is attracted as a result of coupling and feedback between its component subsystems. The interactions of the subsystems form patterns, which become rules or—more accurately—habits governing their interactions at the subsystem level. These patterns of interaction exert upward causation to form the system’s metapattern (note that the system IS the metapattern, the metapattern its not just a property of a system), which then exerts downward causation onto the component subsystems/subpatterns. Together they create a circular governing pattern of the system whole, one which is qualitatively different from the patterns governing its subsystems.

5.3.12 Concurrent Persistence and Change

Thus, even though its subsystems continuously interact and change, the overall circularity (i.e. identity) of the higher order system (defined as ‘class’ in the Theory of Logical Types) is maintained. This is consistent with Galois’ Group Theory, which demonstrates how marked changes taking place within a group do not cause any change in the overall group itself (see Appendix 2). Indeed, the more entities interact and change at the subsystem level, the more they reinforce the circular governing pattern of the system whole, ‘feeding’ the cybernetic feedback loops that maintain system homeostasis. This results in the paradoxical coexistence of persistence and change illustrated in the French proverb “the more something changes the more it stays the same” (Watzlawick et al. 2011), albeit at a different system level or dimension (i.e. different logical level, as per the Theory of Logical Types). This also pertains to Heraclitus’ unity of opposites: despite their apparent opposition, persistence and change must occur together, as one cannot exist without the other4. Watzlawick et al. (2011) suggest that although many theories of change and

4 Watzlawick et al. (2011) illustrate the unity of opposites by noting that if everything in the universe were blue, it would not be possible to have a concept of ‘blueness’. Phenomena only become apparent (i.e. distinguished) through contrast and comparison.
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Persistence have been formulated in Western culture, most of these have been about either change or persistence, not the interrelationship between the two.

5.3.13 System Levels and Variance in Governing Patterns

Aspects of emergent order are also echoed in topology (see Appendix 3, Section A3.2.1). The invariant properties/patterns of topological equivalents can be viewed as the emergent properties (i.e. governing patterns) of the system whole, to which the topological equivalents belong as components. It is similarly reflected in the Theory of Logical Types (see Appendix 2), whereby a collection (i.e. a whole) consists of ‘things’ unified by a common (i.e. invariant) property, which are of a different logical level than the collection (or class) itself. Thus, if the components of a self-organising system are unified into the same topologically equivalent and logical level by invariant patterns/properties, then invariant patterns/properties perhaps represent some aspect of the higher order, self-reinforcing governing pattern exerted downward by the system whole onto its component subsystems (i.e. vertical interaction in downward direction). Conversely, any variant properties/patterns observed in these subsystems represent the lower order patterns of relationship emerging from the interactions between the component subsystems (i.e. horizontal interactions), that also harmonise to generate the system whole (vertical interaction in upward direction). Thus the variance of particular patterns among different components of a system may provide clues as to their driving source.

5.3.14 History Constrains Rather than Determines the Future

Due to the self-reinforcing coupling between subsystems that create system wholes, each new moment is likely (but not guaranteed) to be similar to the previous one. The shape of each moment constrains the possibilities (i.e. phase space) of the next as per process philosophy (Whitehead & Sherburne 1981) and chaos theory (see Briggs & Peat 1989). Paradoxically, however, within these constraints (which form the shape of the system’s attractor in phase space), an infinite number of possible states are still available to the system due to sensitivity to initial conditions and spontaneous emergence (Briggs & Peat 1989, see Appendix 3, Section A3.5.6). Thus, while each new moment often tends to be similar to the previous, it will never be exactly the same, meaning it is fractal in nature (see Appendix 3, Section A3.5.5). Thus reality is inherently unpredictable and uncertain. However, probabilistic prediction is often possible due to the formation of stable patterns when entities couple into feedback loops. As such, in a complexity-based ontology history constrains rather than determines the future, as is the case in the Newtonian ontology.

5.3.15 Order and Chaos Are Co-extant

Apparently stable patterns are not immutable, however, as they are perpetually co-evolving with other entities (Heilgen et al., 2007). In addition, complex systems can become radically unpredictable in certain situations and spontaneously undergo dramatic transformation (Appendix 3, Section A3.5.6). This is because stability and instability co-exist in complex systems: yet another reflection of Heraclitus’ unity of opposites, as well as the Chinese notion of yin and yang (Briggs & Peat 1989). Stable patterns will spontaneously emerge in chaotic systems (Briggs & Peat 1989). Likewise, given a sufficient number of iterations, stable patterns will eventually and spontaneously become chaotic, even in apparently determinate systems, as per chaos theory (Briggs & Peat 1989, Appendix 3). This is particularly the case when: 1) rates of energy, material or information flow through the system continue to increase, amplifying internal instabilities; and/or 2) when the system increases its internal and/or external connections/couplings, creating new feedback relationships that disrupt the system’s existing circular pattern (see Kauffman 1993). In these situations, it becomes more difficult for the system’s circular organisation to apply sufficient negative feedback to damp down disturbances, rendering it susceptible to destabilising amplification due to positive feedback.

Richardson (2005) notes that a key difference between a complicated system and a complex system is history. Whereas a computer or a machine’s present state is largely the same as it was a moment ago (on the macro-scale of human observation—on a quantum scale this is no longer true), making its future state easy to predict, a living system’s state is impossible to pin down because it is temporally coupled with its history in a way that cannot be observed. This makes its future very difficult to predict.
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5.3.16 System Transformation and the Edge of Chaos

When this happens, the system is said to be on the edge of chaos (Kauffman 1993, see Appendix 3, Section A3.6.2). At this point, a small disturbance can be amplified to the point where the system's behaviour quickly becomes chaotic, or turbulent. The increasingly chaotic state of the system indicates a transition or bifurcation point, where the system starts to oscillate between its original governing pattern and new potential governing patterns (see Appendix 3, Section A3.5.3). New governing patterns begin emerging as a result of increases in number and types of couplings, either between the system's component subsystems, or between the system whole and other systems. If its control parameters continue to 'dial up' (i.e. their rates increase), the system begins to wildly oscillate between other dimensions of order (i.e. basins of attraction, or attractors) potentially available to it (Briggs & Peat 1989). In phase space, the surface of the system's attractor (i.e. circular organisation) breaks up as it enters the fractal dimension of indecision and begins to explore the wider phase space available to it (Briggs & Peat 1989). At this point the system can potentially move in three general directions:

1. **Loss of order**: The system is unable to harmonise/self-organise its new interactions/couplings into a new order before the original coupling patterns that maintain its present circular organisation are irreversibly destroyed, causing the system to break apart into its component subsystems through total loss of its circular organisation/attractor.

2. **Maintenance of existing order**: The original circular organisation/attractor manages to dampen out the effects of any new coupling/interactions, causing the system to collapse into its original attractor/pattern (unlikely unless the system’s control parameters are 'dialled down' in time).

3. **Increase or change in order**: the new couplings between the interacting subsystems and/or systems will spontaneously harmonise and create a completely novel (qualitatively different) higher order governing pattern or circular organisation, i.e. a strange attractor.

5.3.17 Scale Dependence of Chaos and Order

A classic illustration of fractal geometry is found in Mandelbrot's (1967) question: “How long is the coast of Britain?” Because the coast is jagged and this jaggedness is self-similar at different scales (i.e. it is fractal), it depends on the size of the units you use to measure it—the coastline is potentially indefinitely long if you use an indefinitely small unit to measure it (see Appendix 3, Section A3.5.5). As such, quantities are also dependent on scale of observation. Jaggedness is a qualitative measure of the system’s chaos and is relative to scale (Capra 1997). For example, if you look very closely along the water's edge it appears jagged. If you stand in a bay and look down the coast the shoreline looks relatively smooth. If you view the coastline from a low plane it appears jagged, whereas if you look at it from higher in space it looks smooth. Thus chaos and order are laminated (Briggs & Peat 1989) and scale dependent. This also works on a temporal scale. Events viewed in a short timeframe may appear random or chaotic, however, when viewed from longer timescales they can often be seen as part of a larger pattern of order that is not apparent in shorter time periods.

According to Richardson (2005), complex systems exhibit a variety of qualitatively different behavioural patterns, and the behaviours observed depend on the scale of observation. For example, it would be impossible to recognise the organisational patterns of a human system at the quantum level, or to explain them using the rules and premises that comprise quantum theory. Therefore the apparent stability or instability of the system is a function of the scale of observation. Imagine yourself observing the dynamic webs of nested systems that comprise reality (system = group of coupled subsystems) from the vantage point of being inside the web, but with you growing bigger (like Alice in Wonderland). The system appears stable when you are viewing it at a spatial or temporal scale whereby the patterns governing it are obvious (when you are looking at just one level or dimension of the system at a time—e.g. a tree). However, as you ‘grow’ and move to a higher temporal scale, the system begins to appear unstable/chaotic as more and more
trees come into your field of vision, in no discernable order\textsuperscript{49}. Now you are observing at the spatial-temporal scale of the transition point between system levels/dimensions. You are seeing a 'mash up' of qualitatively different governing patterns from the two different system levels—you can't see the forest for the trees or the trees for the forest. At this point your perception of the system is shifting from one dimension to another, or from one level of organization (or logical class) to another, creating the sensation of chaos or turbulence. The system appears to ‘flip-flop’ between the two dimensions as you discern the governing pattern from one level, then the other. The governing patterns of both the lower and the higher dimension/level of organization are not simultaneously apparent to the observer, because, being qualitatively different they have to be measured/observed with different 'tools', as per the Theory of Logical Types and emergence (see Appendix 3, Section A3.6.4).

As you keep ‘growing’ through the system, suddenly your field of vision extends out and above the trees, allowing you to see the next system level—the forest. You can no longer discern the apparent chaos of the transition from the lower system, nor can you discern individual trees. Again, as per the Theory of Logical Types and complexity theory, the higher order pattern is qualitatively different from the lower, and cannot be measured or understood using the measures and terms used to describe the patterns at the previous, lower level. For example, you cannot describe the pattern of a forest (e.g. area, connectivity, diversity, composition, edge, dispersion) using the descriptors (qualitative or quantitative) used to describe the pattern of a tree (e.g. height, circumference, trunk, branches, stems, roots, leaves, flowers). In addition, the forest's pattern is not only influenced by the interactions between the trees and other biophysical entities that comprise it, but also by other landscape level systems such as adjacent vegetation communities, fire, and topography. These systems interact with the forest to create larger metapatterns across the landscape, which in turn exert larger governing patterns onto the lower level composite systems. These metapatterns come into view as the observer continues to ‘step back’ from the system to view it from an increasingly large scale.

Larger-still governing patterns come into play at the biosphere level, including atmospheric, hydrological and geological forces, as per Gaia Theory (Lovelock & Margulis 1974). At every level, the patterns that emerge are the result of the co-evolutionary dynamic interplay between higher and lower order systems/patterns. What appear to be isolated\textsuperscript{50} and/or opposing systems or phenomena at one spatial or temporal scale are shown to be unified into larger system patterns at another scale. These patterns represent higher dimensions of order, as per Einstein’s unified spacetime and as conceptually illustrated by Capra (2010) in Figure 5.1. The apparent ‘disorder’ or isolation of a system is actually just confusion on the part of the observer, who either cannot see the larger governing pattern that unifies or controls the macro-behaviour system, or sees an indiscernible jumble of governing patterns from different levels/dimensions because of the transitional spatial or temporal scale at which they are observing the web of systems (i.e. on the edge of chaos just prior to transformation, where the system is undecided and ‘jumping’ between new possible states as it explores its phase space).

It should be noted, however, that ‘snapshots’ of a complex system, such as the ones illustrated above, are singular representations among an infinite multiplicity of possible states available to a particular level of organisation within its phase space (Richardson 2005). Phase snapshots will be qualitatively different at different levels, and the different levels interact with each other in a scale dependent way—as a result, the governing patterns relevant to a particular snapshot at a particular level will change. Those governing patterns that explained the system state at the time of the

\textsuperscript{49} Despite appearances, chaotic behaviour is not the sign of a randomly disordered system (i.e. the entropy that forms in closed systems)—rather it is the product of an underlying pattern of higher dimension order that emerges in open systems far from equilibrium (see Appendix 3, Section A3.3).

\textsuperscript{50} Capra (1997) uses the analogy of a tree to illustrate how we understand a system depends on how we observe it. When we draw a tree, we might include branches, twigs and leaves, and we depict it as an isolated, independent entity. However, in our drawings we usually don’t include the roots, as we don’t see them from our surface perspective. Yet the tree’s roots are often as expansive as its above-ground parts, forming an interconnected network with micorhizal fungi and the roots of other trees and vegetation, such that there are no boundaries between trees. The patterns of relationships, i.e. objects, that we see are dependent on the observer’s perspective and the method of observation.
Chapter 5

snapshot may no longer apply, as both the qualitative and quantitative natures of governing patterns are in perpetual flux (Richardson 2005).

5.3.18 Scale Dependence of Rules and Laws

Thus, from this proposed complexity perspective, seemingly immutable laws governing the universe are actually just patterns given the illusion of immutability by virtue of their persistence in spacetime relative to the observer. This is reflected in Chew’s ‘bootstrap hypothesis’ of the universe (Chew 1968), which rejects the existence of any fundamental properties or entities, including laws, constants, and equations. In the bootstrap view, these properties are understood as flowing from parts of the dynamic web of interconnected events that comprise the universe (Capra 2010), i.e. they are emergent.

Likewise, system ‘boundaries’ are also scale dependent. To the naked eye, the skin appears to be a substantial and impermeable boundary separating us from our environment. However, viewed at a nano-scale skin is semipermeable, allowing exchange of fat-soluble substances, water and small nano-particles. Meanwhile at the quantum scale, skin is revealed as an immaterial pattern of relationships interconnected with the totality of the universe. Thus all seemingly unrelated phenomena are interconnected at some level, bringing us back to the idea that there can be no objective observation and that there is no external reality, only a vast tissue of nested interconnections of which we are a part. Our every thought and action reverberate through this web, however indiscernibly, irrevocably changing the emerging pattern of reality (Wheeler, in Capra 2010), which we understand to be the universe.

Scale dependence also relates to quantum physics, in that the universe’s ‘rules’ of operation change when you start observing things at a very small scale (Prigogine & Stengers 1984). In essence, the observer jumps down a dimension/logical level to view the system at a quantum scale. At the quantum scale, governing patterns of macro-reality’s subsystems can now be discerned, patterns which were masked at larger scales by the downward metapattern exerted by the macro metasystem. As per the Theory of Logical Types, the governing patterns at the quantum level are of a qualitatively different nature to the metapattern operating at the level of classical Newtonian mechanics. For example, Penrose (1995) notes that quantum physics has not rendered classical physics wrong—it simply operates at a different level. Quantum physics cannot be used to explain the classical level of reality any more than classical physics can describe the quantum level. Rather, it’s a matter of recognising that phenomena behave very differently at different scales.

Scale is perhaps also linked to quantum’s classic double-slit experiments showing that the behaviour of a system appears to change depending on what the observer is measuring (Appendix I, Section A1.5.6.2). The relational interpretation of quantum theory (Rovelli 1996) suggests that the entity being observed, such as a photon in the double slit experiment, does not possess any absolute properties, rather its observed properties or behaviours arise from the interaction between the observer the observed entity. By setting up what it is we are going to measure and observe, we determine to some extent the properties of the observed object (Capra 2010). Once again, as Heisenberg himself stated, “What we observe is not nature itself, but nature exposed to our method of questioning” (Heisenberg 1958, p. 81).

From the proposed complexity-based ontology, this situation is understood as arising because qualitatively different governing patterns (i.e. patterns at different logical levels) will be detected depending on the scale and type of measurement. Because orders/levels of pattern differ qualitatively, an instrument/method used to measure one order of pattern will be ineffective when used to measure another. Thus, quantities are observer dependent: they depend on the scale and type of observation. For example, the double slit experiment shows light paradoxically behaving as either a particle or wave depending on how the light is observed or measured. The paradox is resolved by understanding that light appears as particles at one system level or dimension, and as a wave at a higher system dimension—this is because waves in this sense are probabilistic metapatterns formed by interacting particles (Capra 2010). Depending on your method of measurement, you will see the governing pattern of one scale/dimension or the other (i.e. particles
versus waves). Likewise, different orders of pattern cannot be explained using the same theory. While the particle patterns observed in the double slit experiment can be explained using quantum theory, the wave patterns cannot—relativity theory must be invoked. In order to account for this duality a ‘quantum-relativistic’ theory of particles is required (Capra 2010). While it appears that the system’s behaviour is mysteriously changing, in actuality the observer is simply witnessing qualitatively different aspects of the system whole.

5.3.19 Evolution Through Self-organisation

A complexity-based ontology also explains why living systems become more complex over time, and overturns the traditional understanding of the evolutionary role of natural selection, as per the work of Kauffman (1993, see Appendix 3, Section A3.6.3). While isolated (closed) systems progress towards increasing disorder as per the second law of thermodynamics, open systems in continuous interaction with their surroundings progress towards increasing and often transformational order, as per Prigogine’s non-linear thermodynamics (Appendix 3, Section A3.3). These open systems not only become transformed, they also transform and are transformed by the other systems that comprise their ‘environments’, each jockeying to maintain their own circular organisations or identities as they interact (see Kauffman 1993; Maturana & Varela 1980).

As such, self-organising emergent order generates novelty and drives living systems to become more complex over time. Paradoxically, although self-organisation creates novelty, once self-organised systems become established they resist change and begin to limit novelty as they attempt to maintain their circular organisation, or identity. In contrast to its role as understood within the Darwinian paradigm, natural selection also works to limit novelty by squashing new emerging order, rather than creating it (Kauffman 1993). However, as systems become more complex through successive emergent transformations, via “order for free”, they become more resistant to alteration via disturbance and selective pressures (Kauffman 1993).

Margulis and Lovelock’s Gaia hypothesis (1974) also counters the classical Darwinian understanding of evolution, premised on the idea that organisms evolve as they adapt to their environment. The Darwinian notion assumes a somewhat static external environment, whereas in reality “the environment itself is shaped by a network of living systems capable of adaptation and creativity. So which adapts to which?” (Capra 1997, p.222). Capra answers by quoting Lovelock (1991, p.99): “So closely coupled is the evolution of living organisms with the evolution their environment that together they constitute a single evolutionary process,” i.e. an ongoing process of co-evolution of interconnected, self-organising systems. This relates back to the notion of an interconnected and perpetually co-created reality, as posited by autopoiesis (Maturana & Varela 1980) and process philosophy (Whitehead & Sherburne 1981), by Kauffman (1993) with his concept of fitness landscapes, and by Horwitz and Wilcox (2005) in relation to parasitism.

In addition, the work of Margulis and Sagan (1986) and Margulis (1991) has created a strong argument that symbiogenesis (whereby new organelles, bodies, organs and species are formed by the merging of two separate ones) provides a better explanation of evolution than the neo-Darwinian notion of variation being created by chance, through random accumulation of mutations, which are then acted upon by natural selection. Margulis and Sagan (1986) argue that cooperation is an important evolutionary force, not just competition as was emphasised by Darwin, stating “Life did not take over the globe by combat but by networking” (p.15). As such, variety is generated through self-organisation as well as through genetic mutation.

According to Capra (1997), this perspective, whereby new life forms are created by the convergence (i.e. coupling) of living systems, is radically different from the conventional neo-Darwinian view, which depicts life unfolding as species diverge from one another. It forces biologist to acknowledge the important role of cooperation in evolutionary process. Capra states that Darwinism overlooks the fact that all of nature’s struggles occur within a wider context of cooperation, and that organisms network, establish relationships, and live inside one another. This is contrary to the thinking of 19th century social Darwinists who saw nature as being driven by competition—
“Nature red in tooth and claw” as the poet Tennyson put it (Capra 1997, p.226)—and whose views continue to largely dominate modern western thinking.

5.4 Specifying New Territory: A Complexity-based Epistemology

“Not only can we not predict into the next instant of the future, but, more profoundly, we cannot predict into the next dimension of the microscopie, the astronomically distant, or the geologically ancient. As a method of perception—and that is all science can claim to be—science, like all other methods of perception, is limited in its ability to collect the outward and visible signs of whatever may be truth.

Science probes, it does not prove.”

—Bateson (2002)

The Newtonian epistemology flows from the ontology of a material and atomic reality, which exists independently outside of us. As such, it is premised on the assumption that the external world is knowable, and that knowledge is created as our senses send data about this outside world to our minds. Because this reality is objective and separate from ourselves, it is the same for all observers. So it follows that Newtonian epistemology views knowledge as an imperfect reflection, or map, in an observer’s mind of an objective reality, which consists of matter located in space (Heylighen et al. 2007). Knowledge gained about a particular system is a reflection of that system’s pre-existing order (Heylighen et al. 2007).

Because the Newtonian world is one of simplicity, the Newtonian epistemology is also premised on reductionism. Complexity is only apparent. Therefore, any given phenomenon, however complex, can be understood by dismantling it and examining the cause-and-effect and relationships between its parts (Heylighen et al. 2007). Since the Newtonian universe is driven by upward causality (where ‘things’ are causally constructed), time is theoretically reversible, and we can obtain certain knowledge of the past and predict the future, given sufficient information about a system’s present state (Heylighen et al. 2007).

In the complexity-based ontology there is no external substantial reality, just dynamic immaterial patterns of relationships, emerging in a creative flow of becoming (as per Whitehead & Sherburne 1981). Because reality is an interconnected whole (Bohr 1958), one is a continuous participator in its creation, as objective observation is impossible (Capra 2010). In so being, there is no external reality waiting to be discovered, as this requires a stable persistent reality existing independently of the observer. Reality cannot be discovered, only the subjective past can.

As such, this ontology requires an epistemology radically different to that proffered by the Newtonian paradigm, one that is furnished in Maturana & Varela’s (1980) theory of autopoietic systems. In their view, knowing is an act of relating, of coupling with one’s surroundings, through which reality is ‘specified’, rather than revealed. In other words, we do not gather information about reality, we specify or co-create it via our coupling with other entities. The world that we see is “not the world but the world we bring forth with others” (Maturana & Varela 1987, p.245), i.e. reality, with us in it, making itself.

Capra (2010) notes that while the participator notion is relatively new to modern physics, it has long been a central principle of eastern mysticism, whereby knowledge can only be obtained through full participation, never by observation alone. Indeed, some mystic traditions view observer and subject as inseparable and indistinguishable (Capra 2010).

5.5 Summary & Conclusions

After Smuts coined the term holism in 1927, the theory was soon brought down by positivist scientists on grounds of mysticism, because it provided no answer to the question “What is it that is ‘more’ in the whole?” (see Appendix 1). From Appendix 3, we see that this question has now been answered by the chaos and complexity sciences. The ‘more’ constitutes emergent properties, the qualitatively novel patterns of behaviour that spontaneously self-organise in non-linear systems
operating far from equilibrium (Heylighen et al. 2007). A such, we now know that Smuts’ holism was referring to the phenomenon complexity scientists call emergence (Heylighen et al. 2007)—the critical piece of information missing from reductionist thinking, as per Godel’s Incompleteness Theorem, and the source of the qualitative ‘jump’ that takes a system from one logical level to another (Appendix 2), as the greater whole emerges from the interactions of its parts. In furnishing this missing information, chaos and complexity theory have revealed holism and reductionism to be paradoxically wedded in a unity of opposites, as per the ancient teachings of Heraclitus.

In the discussions above, I presented a proposed complexity-based paradigm as a more complete alternative to the Newtonian paradigm. It is based on a synthesis of related concepts in mathematical logic, relativity, quantum physics, holism, Whitehead’s process philosophy, general systems theory, chaos theory, non-linear thermodynamics, autopoiesis, and complexity theory (as outlined in Appendices 1-3). In this complexity-based ontology there is no external substantial reality. Rather, reality comes forth as an active process of relating. Through this process, patterns of relationship are dynamically emerging from nested sub-patterns of relationships, in a circular feedback process of upward and downward causation, occurring simultaneously across/within system dimensions/levels and between system dimensions/levels. At some level all things in the universe are eventually connected via this web of relationships. Therefore the universe is a whole, but it is a whole via relationship, not substance. Those things which appear substantial or isolated only do so because of the scale at which we are observing them—substance and separation (i.e. atomism) are illusions created by spatial and temporal scale.

It is through scale that the paradoxical materialist and idealist notions of the nature of reality become unified in this proposed ontology. At the scale where classic Newtonian mechanics operates, reality can appear and behave as if it is substantial and atomic. At the quantum scale, however, reality is revealed as an incorporeal whole. At certain scales system behaviours are relatively predictable and immutable, whereas at others they are highly dynamic and subject to unpredictable, radical and spontaneous transformation. Thus, at these scales only probabilistic prediction may apply. At one scale the observer may appear temporally or spatially isolated from other systems, allowing for objective observation. However, when viewed from another scale, the observer is shown to be unified with these systems via higher or lower levels of ordering patterns, indicating the impossibility of holding an absolute objective position. As per General Systems Theory, reductionism (upward causation) can be applied when looking ‘downward’ at component subsystems, whereas emergence and holism (downward causation) are applied when looking ‘upward’ at the system whole. Table 5.1 compares the mainstream Newtonian paradigm with the proposed complexity-based paradigm.

Richardson (2005) similarly proposes a philosophy of quasi-critical pluralism, which suggests that no one discourse, neither idealist nor realist/materialist, should dominate. In doing so, he essentially tries to dissolve the stalemate between idealists and materialists by deriving a postmodern argument from complexity science. He suggests this philosophy is quite ‘empty’, not unlike that of Buddhism, in that it does not privilege any one perspective. Heylighen et al. (2007) note that while complexity ideas have had impact in fields outside of the ‘hard’ sciences, such as sociology and organisational management, they have had little penetration in mainstream philosophy, perhaps because of complexity theory’s mathematical and computer-based origins. They suggest another reason could be because analytic Western philosophy finds the holism, uncertainty and subjectivity of complexity inimical.

It should be noted that while a paradoxical conception of a unified reality may be largely to alien to Western thinking, it has long been a central tenet of Eastern philosophy (Capra 2010). The cardinal Buddhist doctrine of pratityasamutpāda (dependent arising) dictates that all phenomena arise together in a mutually interdependent web of cause-and-effect. Eastern mystics recognize the individuality of things while being aware that separateness is relative and that apparently opposing and isolated

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51 As such, the missing information as per the premise of Godel’s Incompleteness Theorem refers to higher dimension patterns of order that are indiscernible at a given scale of observation.
phenomena are actually part of a larger singular one-ness (Capra 2010). Because this notion is difficult to accept in our normal state of consciousness, Zen Buddhists use koans to train their minds to be open to this paradox. Koans are mysterious stories that demonstrate the essential dynamic interconnectivity of apparently paradoxical phenomena (Fitzpatrick 2005). Most cannot be resolved by reason or intellect, and thereby force the practitioner into different level of consciousness or comprehension (Tarrant 2005). Buddhism also posits that Nirvana, the ultimate state of enlightenment, is achieved when the apparent separateness of self and the apparent dualities of the world are revealed as illusions (Capra 2010). Figure 5.7 shows a stroboscopic photo, like those discussed in Section 5.3.6, of a woman waving her arms up and down, giving them a near-solid, wing-like appearance. This bears resemblance to a familiar time-honoured image in Eastern art depicting Buddha and Hindu Gods with multiple arms—further evidence that Eastern mystics grasped the notion of emergent spacetime long before Western physicists did. Perhaps, given its parallels with Eastern mystical worldviews, the ontology outlined above suggests the possibility of a Western scientific path to Nirvana.

**Figure 5.7:** Similarities between a stroboscopic photo (source: Davidhazy 2013) and a thousand-armed Avalokitasvara Bodhisattva, from Dharma Flower Temple in Huzhou, Zhejiang province, China (source: Tengu800, Wikimedia Commons).

52 Examples of Buddhist koans include: What is the sound of one hand clapping? Or (1) a monk asks Baso, "what is Buddha", Baso says: "this mind is Buddha." (2) a monk asks Baso, "what is Buddha", Baso says: "this mind is not Buddha"
Table 5.1. A comparison between the mainstream Newtonian paradigm and the complexity-based paradigm proposed in this Chapter.

<table>
<thead>
<tr>
<th>MAINSTREAM NEWTONIAN PARADIGM</th>
<th>SOURCE</th>
<th>PROPOSED COMPLEXITY-BASED PARADIGM</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reality is material and atomic</td>
<td>Aristotle, Atomism, Newton</td>
<td>Reality consists of immaterial, dynamic and nested patterns of relationship which form an interconnected whole. Patterns which are persistent in time and space relative to the observer appear substantial</td>
<td>Quantum theory, process philosophy, holism, General Systems Theory, chaos theory</td>
</tr>
<tr>
<td>There is an objective reality that is separate from the observer and can be revealed</td>
<td>Aristotle, Descartes, Newton</td>
<td>Because reality is an interconnected whole, absolute objectivity is not possible. Entities that appear to be isolated at one scale/dimension are connected at others. Reality is subjective and observer dependent</td>
<td>Heraclitus, panpsychism, quantum theory, General Theory of Relativity, process philosophy, chaos theory, quantum gravity</td>
</tr>
<tr>
<td>The arrow of time is reversible. All processes are deterministic and theoretically reversible</td>
<td>Newton, Descartes,</td>
<td>The arrow of time is irreversible. Open systems spontaneously become irreducibly complex over time, and closed systems become irreversibly disordered</td>
<td>Non-linear thermodynamics, quantum theory, complexity theory, chaos theory, classical thermodynamics</td>
</tr>
<tr>
<td>Most natural systems behave linearly and predictably—small changes create small effects, and big changes create big effects</td>
<td>Newton, linear mathematics</td>
<td>Most natural systems behave non-linearly because they are coupled through feedback. Small changes can create big effects through positive feedback and sensitivity to initial conditions, and big changes can have little effect due to negative feedback</td>
<td>Non-linear mathematics, chaos theory, non-linear thermodynamics, cybernetics, Group Theory</td>
</tr>
<tr>
<td>Atomic reality reconfigures as the result of cause-and-effect — change is the result of external disturbance</td>
<td>Atomists, Descartes, Newton</td>
<td>Reality is constantly emerging/being created through self-organisation—change is internal, the result of perpetual self-creation</td>
<td>Process philosophy, holism, autopoiesis, complexity theory, non-linear thermodynamics</td>
</tr>
<tr>
<td>Reality is reducible—wholes are equal to the sum of their parts</td>
<td>Descartes, Newton</td>
<td>Reality is irreducible—wholes are greater than the sum of its parts. Self-organising systems spontaneously create higher order patterns that are qualitatively different from and therefore cannot be explained by the properties of their parts</td>
<td>Holism, General Systems Theory, complexity theory, non-linear thermodynamics, Theory of Logical Types, Godel's Incompleteness Theorem</td>
</tr>
<tr>
<td>Topic</td>
<td>Author(s)</td>
<td>Description</td>
<td>References</td>
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<tr>
<td>Reality is the product of upward causality, therefore there can be no true novelty</td>
<td>Descartes, Newton</td>
<td>Reality is the product of upward + downward (circular) causality via self-organisation. Through emergence, each moment paradoxically has the capacity for infinite novelty while being simultaneously constrained by its spatial and temporal couplings</td>
<td>Process philosophy, complexity theory, chaos theory</td>
</tr>
<tr>
<td>History determines the future. The future is deterministic and predictable</td>
<td>Newton, Descartes, Laplace</td>
<td>History constrains rather than determines the future. The future is uncertain, and predictability is probabilistic and scale dependent</td>
<td>Chaos theory, process philosophy, quantum theory</td>
</tr>
<tr>
<td>Chaos is equivalent to entropy; it is a measure of system's randomness and disorder</td>
<td>Classical thermodynamics</td>
<td>Chaos signals deep, underlying system order that appears as disorder because of the scale of observation. Chaos indicates the system is being observed at a point where it is vacillating between qualitatively different dimensions/logical levels</td>
<td>Non-linear thermodynamics, chaos theory</td>
</tr>
<tr>
<td>Instability/chaos in ordered systems is caused by external disturbances</td>
<td>Newton</td>
<td>Chaos is intrinsically embedded in order and vice versa—they are co-extant. Chaos and order are scale dependent</td>
<td>Pythagoreans, complexity theory, chaos theory, Gödel's incompleteness theorem, Theory of Logical types</td>
</tr>
<tr>
<td>Space and time are separate and absolute entities—they are the backdrop/container for the material universe and the immutable laws that govern it</td>
<td>Plato, Newton</td>
<td>Space and time are unified in the fourth dimension as spacetime. Spacetime is not an absolute entity or backdrop to the universe. It is the scope of an emerging, self-organising universe. Laws of the universe are actually large-scale coherent patterns of the universe's self-creation</td>
<td>General Theory of Relativity, quantum gravity, emergentism, process philosophy</td>
</tr>
<tr>
<td>Order, complexity, and novelty evolve divergently as the result of natural selection</td>
<td>Darwin</td>
<td>Order, complexity, and novelty emerge spontaneously through self-organisation, i.e. convergence of systems through coupling. Natural selection squashes new order rather than creates it</td>
<td>Complexity theory, symbiogenesis</td>
</tr>
</tbody>
</table>
Chapter 5
Through the Complexity Lens: Cognition, Learning, Knowledge & Organising

"A human being is a part of a whole, called by us 'universe', a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest... a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty."

— Albert Einstein

6.1 Introduction: Ptolemy and Copernicus Skin a Cat

The second step of Watzlawick et al.’s (2001) principles of formulation involves opening our minds to alternative ways of thinking, in light of our revised assumptions; this is the focus of this chapter. The value of opening our minds to new ways of thinking is conveyed by the story of Ptolemy and Copernicus. Kauffman (1995) notes that from ancient Greek times until Copernicus laid out his heliocentric theory, we in the West assumed ourselves to be the centre of the universe, as laid out in Ptolemy’s geocentric solar system. The persistence of the geocentric paradigm can be attributed to a core belief underpinning the religious cultural and moral fabric of the time: that man is the centre of God’s divine creation (Kauffman 1995). However, the paradigm was also buttressed by 1600 years of empirical observation proving the predictive power of Ptolemy’s geocentric theory. This was courtesy of the theory’s complex system of epicycles, which mathematically resolved the paradox of retrograde planetary motion created by placing earth in the centre of the solar system (Debus 1978).

Copernicus and Ptolemy’s story exemplifies the old adage that ‘there is more than one way to skin a cat’. It also brings us back to Korzybski’s map vs. territory metaphor. Bateson (2000), by example, argues that believing common colds are transmitted when evil spirits are discharged out of a person’s mouth and nose during a sneeze then inhaled by others can be just as effective a ‘map’ (i.e. abstraction of ‘reality’) for managing public health as one which views colds being transmitted by microbes. Indeed, the fact that we can devise qualitatively different ways of explaining (i.e. mapping) and predicting the same phenomenon (see Maxwell 2000) is why science operates in paradigms as outlined by Kuhn (1962; see Appendix 1, Section A1.6.4), as will be discussed in Chapter 7. Science is typically a process of searching for evidence to reinforce ‘normal’ scientific paradigms, rather than a methodical uncovering of reality’s ‘true’ nature. Despite our best intentions to be objective, the paradigm we lend our commitment to is largely an unconscious matter of faith.

Today we regard the idea of geocentric universe as absurd. However, we should not let our present-day sophistication obscure the important lesson served by the history of Ptolemy and Copernicus’ theories. Their story demonstrates how strongly our minds and society shape our perception of reality—as per Kant’s transcendental idealism—and how science can be enlisted in shoring up these perceptions. In this chapter I will discuss key phenomena relevant to the problem of knowledge transfer—namely cognition, learning, knowledge and organising—in relation to how they have been understood within the Newtonian paradigm, and then compare this with how they can be alternatively explained from the perspective of a complexity-based paradigm, as synthesised in Chapter 5. Both paradigms clearly have predictive power when describing these phenomena. We will, however, see how the complexity-based paradigm helps resolve some of the learning paradoxes created by the central Newtonian assumption: that reality is material, external and independent. This mirrors how Copernicus’ theory resolved the paradox of retrograde motion in Ptolemy’s geocentric system by challenging its core assumption: that the earth is the centre of the universe.
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6.2 Cognition, Learning & Knowledge

“Imagination ... is more important than knowledge. Knowledge is limited. Imagination encircles the world.”
— Albert Einstein

The field of cybernetics first emerged during the Second World War (see Appendix 1, Section A1.6.1 for details). Cybernetics is concerned with patterns of self-regulation in both organisms and machines. According to Capra (1997), feedback is the centrepiece of cybernetics, which distinguishes it from other types of mechanistic thinking. Feedback is the circular linking of causally connected elements in a system. The circularity of its connections means the first input of the cybernetic system is affected by its last output every time the system cycles, making these systems non-linear. When the feedback loop is negative, deviations from equilibrium are suppressed and the system becomes self-regulated (Heylighen et al. 2007). Two types of feedback links were recognised: negative, or self-balancing feedback; and positive, or self-reinforcing feedback, also known as ‘run-away’ or amplifying feedback (Capra 1997). The cyberneticists focused on self-regulating negative feedback systems, those which dampen change and maintain stable states, paying little attention to positive run-away feedback until the 1960s. Cybernetic machines incorporating feedback became a central focus of engineering at this time (Capra 1997). Cybernetics had a strong influence on industrial engineering and management in the 1950s and 60s, where it was used to solve practical technological problems in systems engineering, systems analysis and systemic management (Capra 1997).

Also, during the 1950s and 60s, cyberneticists devised information and communication theory to help invent sophisticated information processing machines in the form of digital computers and artificial intelligence. At the same time, Ashby (1952) was developing cybernetic models of the brain, where the brain was conceived as a logical circuit with neurons as base components. In Ashby’s view, animals, like machines, behave in predictable ways due to chemical and physical cause-and-effect (Capra 1997). For the first half of the 20th century, studies on learning had focused on observable behaviours and behavioural modification via stimulus and response, conditioning, reinforcement and punishment (Jashapara 2004, see Appendix 4, Section A4.4.1). This was the realm of behavioural psychology, or behaviourism, which was the principal branch of psychology during this time. However, the cyberneticists’ correlations of human intelligence with computer intelligence led to a new cognitive understanding of brain function. In this view, the brain is seen as an information-processing machine, much like a computer: rules based, subject to central logical processing, and possessing local storage (Capra 1997). This led to the ‘cognitive revolution’ initiated by Chomsky (1959), which overturned behaviourism and led to cognitive approaches taking over as the dominant paradigm in psychology. During this time, Broadbent devised his information processing model of cognition, Putnam devised his computational theory of the mind (Horst 2009), and Neisser introduced the term ‘cognitive psychology’, a field which views people as dynamic information-processing systems (Thomas 2010). The computer sciences further reinforced the mind as a computer perspective by using terms such as ‘intelligence’, ‘memory’, and ‘language’ in relation to computers (Capra 1997).

Whereas behavioural psychology traditionally viewed learning as a statistical change in behavioural response, cognitive psychology views learning as a change in states of knowledge (Jashapara 2004). Cognitive psychology is based on the notion that the mind operates very much as a computer. Its key assumptions are that mental processes are logically based on rules or algorithms in information processing models, and that the scientific method can reveal the mechanism of human cognition by studying individual components of mental processes (Zhong-Lin & Dosher 2007). Thus cognitive psychology applies an information processing perspective to learning (Jashapara 2004), one that assumes that people develop and use mental models that are more or less accurate pictures of reality (refer to Appendix 4, Section A4.4.2 for more details on these concepts).

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53 When positive and negative feedback links combine in a loop, if the negative links are odd in number the overall effect will be negative feedback, whereas if there an even number of negative links, the overall effect will be positive (Capra 1997).
because of its links with mechanistic science, engineering and the military, cybernetics held much prestige and influence in scientific institutions, which increased with the rapid spread of computers (Capra 1997). Despite very early arguments that brains “operate on the basis of massive complexity, storing information distributively and manifesting a self-organising capacity that is nowhere to be found in computers” (p.70), the cybernetic notion of cognition quickly swept these arguments aside and ‘cognition as information processing’ became the basis of cognitive science and brain research for the following thirty years (Capra 1997). Capra (1997) compares the enthusiasm during the invention of computers for the ‘mind as a computer’ metaphor, with the ‘body as a clockwork’ metaphor that so excited thinkers in the days of Descartes, when clocks—at least as revolutionary as computers in their time—had just been invented.

6.2.1 Traditional Information Processing View of Cognition

As detailed above, traditional cognitivists regard brains as passive mirrors of reality—cybernetic, deductive machines that function like computers (Stacey et al. 2000). Based on their experiences, individuals construct internal mental models representing external reality. They are equivalent to computational structures in a person’s working memory that allow them to explore and test different options in their minds prior to taking action (Jones, Ross, et al. 2011, citing others). These models serve as subjective theories about how the world works (Markus & Zajonc 1985), and serve to direct information acquisition and processing, and storing of knowledge, thereby serving as a template for routine behaviours (Beratan 2007, citing others therein). Learning is understood to occur when one changes their mental models such that they are better able to explain or predict reality.

However, there are a number of problems with this information processing view, which will be discussed in the sections that follow. Given its Newtonian assumptions, the traditional cognitive view of the brain, learning and knowledge is not supported by the complexity-based ontology proposed in this thesis. Shotter (1994) states that our notion of mind as something we are in possession of—“an internal, secular organ of thought which mediates between us and the external reality surrounding us” (p.22), providing an internal representation of an outer external reality—is a myth. However, he states that these ways of thinking about ourselves are so ingrained that it is almost impossible to imagine or speak of ourselves in any other way. Capra (1997) argues that while the ‘mind as a computer’ metaphor was initially a useful framework for scientific understanding, by the 1960s it had hardened into dogma. Neurobiology into the 1970s no longer even questioned the origins of and assumptions underlying the information processing approach to cognition. Thus, despite new scientific developments refuting many of the cybernetic models54, the cybernetic view of cognition and technology is still widespread (Capra 1997).

As such, Capra (1997) states that the idea of cognition without information processing requires a radical expansion of our scientific and philosophical framework. This is supplied by a number of alternative theories whereby cognition is viewed as an active process of relating, as an entity interacting with its surroundings, i.e. other entities. These theories include: the autopoietic or systems theory of cognition (Maturana & Varela 1980, 1992), otherwise known as the Santiago theory of cognition; the dynamical systems views of embodied cognition (e.g. Varela et al. 1991; Wilson & Foglia 2011); and constructivist views of mind and knowledge (Bakthin 1986; Shotter 1994). In the sections below, I assemble a synthesis of these theories and discuss them in comparison with the information processing view of cognition and recent neuroscience research, and in relation to the complexity-based ontology proposed in Chapter 5.

6.2.2 Santiago Theory of Cognition

Maturana and Varela (1980, 1992) apply their theory of autopoiesis (Appendix 3, Section A3.3.4) to understand cognition as a continuous process of coupling (feedback) between an organism and other systems that comprise its environment. From this, they make the radical postulation that the

54 While traditional cognitive science views the mind as an ‘abstract information processor’ and has little concern for the mind’s connections with the outside world, the ‘embodied’ view of cognition sees the mind as being in relationship with the body and its environment, and the environment as part of the cognitive system (Wilson & Foglia 2011).
process of circular organisation, with or without a nervous system, is identical to the process of cognition. They thereby conclude that all living systems are cognitive systems; therefore living is the process of cognition. This systems theory of cognition, whereby even the simplest living systems (e.g. bacteria) are capable of cognition, will be henceforth referred to as the Santiago Theory.

An important aspect of the Santiago view is that an organism responds to stimuli, or disturbance, by changing its internal structure or state, rather than by simply reacting—i.e. cognition is embodied. It does so in order to maintain its circular organisation (i.e. identity) in face of the disturbance\(^55\). Because the organism is autonomous, it specifies its structural response; the disturbance only serves as a trigger. According to Maturana and Varela, organisms only respond to a tiny fraction of the stimuli in their environment. Whether they do so or not is dictated by their structure, which determines what they can perceive. When an organism responds to stimuli by changing its structure, this may in turn cause the source of the stimuli to counter-respond by changing its own structure. This creates a cascade of stimulus-response, which amounts to structural coupling between the two living systems. Behaviour patterns emerge from this coupling (Maturana & Varela 1980) as per Bateson’s dyad (outlined by Visser 2007, see Appendix 4, Section A4.4.1). By dynamically recreating themselves with each interaction, together living systems bring forth a world. For Maturana and Varela, cognition is an act of creation.

Thus, in the Santiago view, cognition is not a process whereby an organism makes a representation of its external environment; it is a process whereby an organism co-creates a world with its environment\(^56\) while attempting to maintain its circular organisation. Organisms are constantly immersed in a network of interactions, i.e. cognition. As an organism interacts (i.e. couples) with other systems, they create a shared “history of evolutionary changes and transformations” through which they become mutually adapted to each other (Proulx 2008, p.16). Capra (1997) sums up this view:

A living system is a multiply-interconnected network whose components are constantly changing, being transformed and replaced by other components. There is great fluidity and flexibility in this network, which allows the system to respond to disturbances, or stimuli...Certain disturbances trigger specific structural changes, i.e. changes in the connectivity throughout the network. This is a distributive phenomenon. The entire network responds to a selected disturbance by rearranging its patterns of connectivity. (p.261)

As organisms become more complex, so do their cognitive interactions, as is manifested by the nervous system and brain in higher organisms. Having a nervous system\(^57\) serves to enlarge the domain of interactions, the number of relations (i.e. possible behaviours) into which the organism may enter (Maturana & Varela 1980); as such, having a nervous system allows an organism’s behaviour to become highly plastic (Maturana & Varela 1992). This is consistent with Kauffman’s (1993) NK models (Appendix 3, Section A3.6.2), which show that increasing connectivity moves complex systems toward the edge of chaos where their responsiveness and capacity for novel behaviour is enhanced. The nervous system therefore does not create cognition. Rather cognition is simply the actual behaving of the organism in this domain of possible interactions (Maturana & Varela 1980); as such, all knowing is doing (Maturana & Varela 1992).

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\(^55\) When a living system enters into a cognitive interaction, this causes changes to its internal state, but its overall circular organisation is maintained so it does not lose its identity (Maturana & Varela 1980).

\(^56\) Capra (1997) notes that even bacteria respond to their environments, sensing chemicals, swimming toward sugars, away from acids, and moving away or toward heat or light. Such tiny acts of cognition can have profound implications as per Lovelock’s Gaia hypothesis (Appendix 1, Section A1.6.3). Heat stimulates bacteria to grow, which increases soil weathering, which increases CO\(_2\) removal from the atmosphere. Thus, by responding to heat, bacteria bring forth a cooler planet, albeit indirectly through coupling with a vast multitude of other processes on a multitude of scales (Capra 1997).

\(^57\) Maturana and Varela (1992) note that while the nervous system is also both self-organising and self-referring, it is also subject to the larger circular organisation of the whole organism.
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Thus, what traditional cognitive psychologists refer to as a schema, mental model or mind map is not some defining entity in the brain that controls behaviour. Rather, it is a pattern of behaviour that has emerged in relationship with others and the environment and become self-reinforcing with repetition over time (Stacey 1996a). The pattern is dynamic, not immutable. However, with repeated iterations it gains cohesion, becoming more stable and difficult to alter. This explains why it is so difficult to provoke double-loop learning (as per Argyris & Schön 1996) or second order behaviour change (as per Watzlawick et al. 2011) in an individual—it is attempting to transform a cohesive pattern of behaviour that has become highly resistant to change. Because this pattern describes a person’s actual behaviours, it is essentially equivalent to Argyris and Schön’s (1978) theory-in-use, but without having to ascribe behaviours to a theory in order to reconcile them with an assumed mental model. Assuming a pattern of relating is a real ‘thing’—a mental model stored in the brain representing reality—is an error in logical typing, as per the Theory of Logical Types.

Given Maturana and Varela view all entities (living and non-living) as units of interaction, Capra (1997) sums up their view as follows:

…‘no things exist’ independent of the process of cognition. There are no objectively existing structures; there is no pre-given territory of which we can make a map—the map-making itself brings forth the features of the territory.” (p.264)

Maturana and Varela do not deny the existence of a material world. Rather, they argue that it is in the making instead of being pre-determined: mind and world emerge together. Thus cognition is not a process of representing an external world, it is creating that world, a process enhanced by language and abstract thought (Maturana & Varela 1992). Their view, that nothing exists independently of cognition, is essentially panpsychic (see Appendix 1, Section A1.4.2). This parallels the contrast between the Newtonian notion that space and time constitute an absolute and inert backdrop for the universe, and quantum gravity theory that a unified spacetime emerges from the dynamic patterns of interaction that comprise what we perceive as the material universe (see Appendix 1, Section A1.6.6).

6.2.3 Dynamical Systems View of Embodied Cognition

The dominant information-processing view of cognition holds that the “body is peripheral to understanding the nature of mind and cognition” and that “there are no computations without representations” (Wilson & Foglia 2011). Likewise, the connection between the mind and the outside world has been traditionally believed to be of little theoretical importance (Wilson 2002). Cognition is believed to occur when the mind solves problems by manipulating symbols representing the ‘real world’ to solve problems (Wilson & Foglia 2011). In more recent years, however, there has been a burst of empirical research on embodied cognition. Proponents of embodied cognition (e.g. Clark 1998; Lakoff & Johnson 1999; Varela et al. 1991) disagree with the dominant view, and argue that:

Many features of cognition are embodied in that they are deeply dependent upon characteristics of the physical body of an agent, such that the agent’s beyond-the-brain body plays a significant causal role, or a physically constitutive role, in that agent’s cognitive processing. (Wilson 2002)

In her review, Wilson (2002) cites a number of authors who put forward a dynamical systems view (i.e. complexity view) of embodied cognition. For example, Thelen and Smith (1994, cited in Wilson 2011) argue that novel behaviours and solutions to problems emerge through bodily activity, and that infants mature cognitively through limb movements in changing contexts. According to Wilson, those with the dynamical systems view minimise (or even deny) the need for

58 Their views on cognition reflect the panpsychic notions of physicists and philosophers such as Spinoza, Whitehead, Jeans and Bohm, all of whom argued that mind and matter are inseparable—that there is no mind without matter and no matter without mind.
a centralised representational processor\textsuperscript{50} (as per the traditional cognitive view) to guide an organism’s behaviour, arguing that intelligent behaviour emerges through self-organising local interactions in real time.

Varela \textit{et al.} (1991) fuse autopoietic notions of cognition with Merleau-Ponty’s (1962) phenomenological perspective\textsuperscript{50} on cognition, in their \textit{enactive} view of cognition. Enactive cognition\textsuperscript{63} suggests that one’s experience and knowledge of the world arises through coupling of the brain, body and world, through one’s bodily engagement with the environment (Varela \textit{et al.} 1991). Thus, enactive cognition is a step beyond the idea of embodied cognition, as it includes an organism’s environment as well as its body as part of the cognitive process.

In the dynamical systems view, processes rather than structures are the basis of consciousness. Consciousness emerges from large-scale dynamic patterns of activity over multiple frequencies (called ‘brain signatures’) rather than from specific neuronal circuits (Noé & Thompson 2004, citing others therein). Thus, cognition and perception are intrinsically temporal—they happen \textit{in} time, rather than \textit{over} time (Noé & Thompson 2004, citing others). This is also consistent with the Santiago theory of cognition.

The dynamical and Santiago views of cognition are logical extensions of the complexity-based ontology proposed in Chapter 5. This ontology is likewise premised on a reality being perpetually constructed through nested patterns of interactions, one which is ordered in a scale dependent way; cognition is also scale dependent\textsuperscript{62}. Through cognition, we bring forth a reality with other entities, which if mapped mathematically represents a subset (or map) of the possible behavioural phase space available to us. This phase space is constrained by the present bodily structure (recognising it reconfigures with every act of cognition) of each interacting entity, and the other systems they are coupling with. Consciousness, self-awareness, behaviour, communication, learning, knowledge and language are all just extensions of cognition—stable higher order patterns of interaction that emerge from iterative couplings between living systems.

6.2.4 Consciousness: Mind & Self

\textit{“Transcendence constitutes selfhood”}
—Heidegger (1953)

Shotter (1994) argues that our current Newtonian world view, where we view ourselves as “all equal, self-enclosed (essentially indistinguishable) atomic individuals, possessing an inner sovereignty, each living their separate lives, all in isolation from each other—the supposed experience of the modern self—is an illusion” (p.45). In the constructivist\textsuperscript{63} perspective, by

\textsuperscript{50} Total denial of representations in cognition cannot, however, account for anticipatory or “representation-hungry” behavior, such as reasoning about absent or non-existent circumstances, planning or imaging (Wilson & Foglia 2011).

\textsuperscript{50} Merleau-Ponty (1962) opposed notions first proposed by Locke that perception is the causal product of atomic sensations. Rather, he proposed that body and perception cannot be disentangled, that perception emerges through the body’s direct experience with the world.

\textsuperscript{62} We are only consciously aware of things at a particular perceptual level, as dictated by our structure and our circular pattern as a whole (i.e. the whole human level). For example, Beratan (2007) notes that our sensory system is most attuned to those stimuli within the spatial and temporal ranges relevant to individual and group survival. Thus, within the dimension of our potential awareness, we tend to be largely unaware of smaller patterns around us (e.g. ants crawling through the grass at our feet), because they are less likely to interfere with our circular organisation. We are more likely to be aware of larger, higher-order metapatterns that have the potential to disrupt our own circular organisation. Nonetheless, we are coupling with all of reality, all of the time, at scales beyond our level of conscious perception. Our cells and organs are continuously undergoing cognitive processes that we are completely unaware of, interacting with ourselves and their external environment to create their own patterns of circular organisation. You cannot ‘know’ as a cell does, because your emergent cognitive structures are qualitatively different from that of a cell (see the ‘darkness principle’: Cilliers 1998; Richardson 2004). Likewise, because of the vast interconnectivity of the universe, we are indirectly coupled to the whole of the universe via quantum and cosmic-scale metapatterns we’re completely unaware of, as per quantum theory and chaos theory, and as demonstrated by Crutchfield’s billiard ball example in Appendix 3, Section A3.5.6.

\textsuperscript{63} Stacey \textit{et al.} (2000), note that constructivist perspectives are premised on the work of social psychologists from the 1920s and 30s, namely Mead (1934), Vygotsky (1962) and Bakhtin (1986)
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contrast, mind and self are not pre-existing—they emerge in social relationship, and are an internalisation of these relationships\(^64\) (Stacey et al. 2000). Infants have an innate urge to relate; relationship is the structuring process for mind and personality, which arise in the pattern of relating (Stacey et al. 2000, citing others). Mind emerges between an individual and the others he or she is in relationship with—it is between them, not individually held within them, emerging through the medium of language (Shotter 1994).

The Santiago interpretation of cognition outlines a process by which the mind and self emerges in relationship. According to Maturana and Varela (1992), when you become aware of something you automatically couple with it, as awareness inevitably triggers internal structural changes within you. Thus awareness is an act of cognition, an active process of relating. This is supported by recent neuroscience research indicating that perception is not a passive process, rather it is active and attentional, and occurs through a person’s active exploration (Noé & Thompson 2004). However, while awareness of one’s environment is common to all living thing, self-awareness—or consciousness—only appears to occur in higher animals. According to Maturana and Varela (1992), consciousness is meta-awareness—it is awareness that you are aware, knowing that you know. This relates to Jean-Paul Sartre's considered response to Descartes' thesis "I think therefore I am". Sartre (1960) argues that the consciousness that says 'I am' is not the consciousness that thinks. When you are aware that you are thinking, that awareness is not part of thinking; it is a qualitatively different dimension of consciousness, of a different logical type (see Appendix 2). If one’s mind and self were nothing but thought, you wouldn't know that you were thinking (Tolle 2006). Consciousness is a higher logical order of cognition that emerges from lower order stimulus-response coupling or awareness\(^65\). In being conscious, one then makes a distinction between self and others.

A being which is self-aware not only couples with its environment to bring forth an external world, but also with itself to bring forth an internal world of imagination. This in turn increases the domain and complexity of its potential interactions with the environment (Maturana & Varela 1992), leading to even greater responsiveness and behavioural plasticity, as per Kauffman’s NK models (1992).

6.2.5 Communication and Language

In the traditional information processing view of cognition, communication is regarded as ‘information transmission’. From Maturana and Varela’s (1987) autopoietic perspective, however, social phenomena are said to occur when reciprocal coupling between organisms (i.e. cognition) create a ‘third-order’ unity, which is a stable pattern of interactions. The coordinated behaviours that emerge from this third-order unity are referred to as communication (Maturana & Varela 1992). As such, communication is not an exchange of meanings (things) derived from information or individual mental models; rather, it emerges from the dynamics of structural coupling (Capra 1997). Communication is common to all living things, but becomes more complex as nervous systems become more complex. The authors distinguish between instinctive and learned communication. Instinctive communication is derived from structures that have arisen in an organism’s development\(^66\) through the course of its shared evolutionary history. Learned communication arises between organisms from their history of social interactions. Because learned communication is specific to the context and social history of the organism, it requires a complex nervous system.

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\(^64\) Jean-Paul Sartre (1943) describes consciousness as 'nothing' (not a thing) but an activity ('a wind blowing from nowhere towards the world'). As consciousness is nothingness, it is not subject to the rules of causality, "it is always what it is not, and is not what it is," (quoted in Audi 1999, p.812).

\(^65\) Our awareness and consciousness can be understood as emerging from the circular pattern that emerges from the harmonisation/self-organisation of our living parts (embodied cognition) and the harmonisation between ourselves and our environment—i.e. our cells, organs, air, water soil, microbes, other organisms, etc. (enactive cognition). To plan and design a ‘human’, or other higher order organism, is inconceivable, given the vast complexity of interactions that would have to be planned for and coordinated. However, the creation of an organism becomes more conceivable when viewed from the perspective of self-organisation, starting with a single unicellular zygote, self-organising through its internal and external interactions into a blastula, which further self-organises into greater and greater orders of complexity until an entire living organism emerges.

\(^66\) These developmental structures have likewise arisen from the shared co-evolutionary history between organisms, i.e. they did not evolve on their own, they emerged from relationship—the long-term patterns of interaction between organisms.
Maturana and Varela refer to learned communication as linguistic, and note that it is common to many animals.

However, linguistic communication does not become language until there is communication about communication, i.e. metacommunication at a higher logical level (see Appendix 2). Capra (1997, p.280) illustrates this using an example he was provided by Maturana. Every morning a cat meows in the kitchen and its owner gives it milk. This is linguistic communication, a mutual coupling of interactions (the cat signalling, the owner responding). If one morning the owner ran out of milk and ignored the cat’s meowing, and the cat was to say, “Hey, I’m meowing, why haven’t you brought my milk?” this would be language as it is communication about communication. Once metacommunication is possible, language begins to emerge, allowing for increasingly complex coupling of peoples’ thoughts and actions (Maturana & Varela 1992), and therefore even greater behavioural plasticity (as relates to Kauffman’s 1993 NK models).

Capra (1997) distils Maturana and Varela’s (1992) ideas as follows. Language is comprised of words, which are tokens for the linguistic coordination of actions, i.e. words are linguistic representations of structural couplings. Words create the notion of objects by linguistically distinguishing a set of relationships from the larger web of dynamic relationships in which they are networked (i.e. their environment). Objects are essentially linguistic distinctions of linguistic distinctions; thus from our language a hierarchy of logical types emerges (Capra 1997).

A key feature of language is that it allows those who use it to describe themselves and their circumstances using linguistic distinctions. Thus consciousness (self-awareness) and self-differentiation are essential precursors to language (Maturana & Varela 1992), as they are for imagination, which is self-projection. The idea that objects are linguistic distinctions within our consciousness echoes Hegel’s absolute idealism, which posits that objects must exist in our minds prior to becoming real and material.

Shotter (1994) draws a distinction between representational-referential communication, which is cognitive in the traditional sense, in that it attempts to represent an external reality that will be passively understood by others, versus rhetorical-responsive communication, everyday ordinary conversation which consists of people responding and justifying themselves to each other as persuasively as possible. Rhetoric involves trying to convince others to let you do as you wish, or to cooperate with you, which is cognitive in the Santiago sense, in that it involves patterns of interaction between parties attempting to maintain their own circular organisation. Shotter (1994) notes that although rhetorical-responsive communication is used far more often than representational-referential, it is completely ignored by traditional cognitivists.

6.2.6 Memory and Imagination

The Santiago view of cognition is also supported by recent neuroscience findings on memory and imagination. Buckner and Carroll (2007) show that remembering is in essence a constructive, imaginary process, rather than one of retrieving stored memories, as per the information processing view of cognition. Thus, the neural mechanisms involved in remembering an event and imagining the event are the same—we do not reproduce events with our memories, we construct them (Schacter & Addis 2000). Every time a memory is activated, it is reconstructed and changed based on the individual’s present context, explaining why our recollections of past events are so variable and unreliable (Schacter & Addis 2000). Prospection, the ability to project oneself into an imagined future, involves thinking about the future, remembering the past, and conceiving the viewpoints of others—all of which use the same core brain network (Buckner & Carroll 2007). Interestingly, the brain regions activated during prospection mode are identical to those activated when the brain is at ‘rest’, suggesting that prospection (i.e. imagining) is the brain’s default state when not engaged in demanding tasks (Buckner & Carroll 2007). This makes sense from a Santiago perspective, whereby cognition is understood as a continuous process of an organism coupling with itself (body and imagination), other systems around it, and their shared history.
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As a consequence, we do not have an unmediated perception of reality—our representations of reality are largely a product of our imagination (Kennedy 2012, citing others therein). Thus, the past is always being reinvented and personal history—who you thought you were and who you think you are now—is changing every moment. We cannot perceive anything in the world without it being shaped by our memories, desires, dreams, etc. Indeed we imagine the current moment. Simply imagining an experience changes our brain activation patterns and therefore transforms our reality by changing how we perceive and act into it (Kennedy 2012, citing others).

However, our potential to transform our reality through imagination is constrained because we do not live alone—we live in social and biophysical systems that constrain our imaginations and what is possible (Kennedy 2012, citing others). As such, our imaginations couple us spatially (in terms of other systems) and temporally (in terms of past states) to the present and the past. Our bodies also serve to couple us with the past, through our shared evolutionary history. These couplings shape the present moment and constrain the next by delimiting our phase space, the domain of possible interactions available to us. However our imaginations also couple us with the future—but in a creative rather than a constraining way. For within the constraints imposed by our past and present lies an infinity of possible future states (as per chaos theory, Appendix 3, Section A3.5.4). And as we imagine the future, we enact it. Thus, we are not predicting the future via analysis of information stored in our memories. Rather, we are creating the future through our imaginations. Again, this revives Hegel’s notion that objects must exist in our consciousness before becoming real and material—what the mind can believe, the body shall achieve, as it is often said. If one abandons the determinism of the Newtonian paradigm and accepts instead Prigogine’s claim that there is an arrow of time (Appendix 3, Section A3.5.7), that reality is perpetually under construction, then the future can only ever be imaginary. In so being, the future is imagination—the two are indistinguishable. Hence, the notion of prediction becomes paradoxical. This resonates with Kauffman’s (2012) notion that “Consciousness is a participation in The Possible, an ontologically real Res potentia.”

Through language, we navigate our constraints and coordinate our imaginations with others. This coordination radically expands the domain and complexity (plasticity) of interactions we can potentially enter into. Hence, it also expands the range of possible futures we can co-create, for better or for worse. Imagination is not neutral—wherever it takes us there will be winners and losers; and our actions do not necessarily bring about the effects we imagined (Kennedy 2012, citing others), given constraints imposed by our histories and the unpredictable effects of our interactions.

6.2.7 Learning and Knowledge

The traditional information processing view of cognition is premised on there being an external reality that is knowable. As such, knowledge is created as we observe reality through our senses, then store it in our minds as a mental representation of the actual world. We learn when we use new knowledge to adjust our mental models to be a more accurate representation of external reality. In so doing, we can make better decisions about how to act, in terms of reconfiguring reality to our advantage and to improve our evolutionary fitness (Capra 1997). Decision-making occurs as the brain identifies and evaluates if-then hypotheses based on its mental models and memories, compares the various alternatives, then makes a boundedly rational decision (Beratan 2007).

However, Nesbitt and DeCamp (1977) found that when asked about their behaviours, people rarely interrogate their memory to assess how it is they processed information to decide on an action. Rather, they tend to resort to a pool of culturally acceptable explanations, or theories, for how they felt and behaved, the likely equivalent of what Argyris and Schön (1996) refer to as people’s espoused theories (see Appendix 4, Section A4.4.2.2). People apply or generate causal theories about their

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67 Citations from interviews in the Canadian Broadcasting Corporation’s Idea radio program.

68 Kauffman (2012) defines Res potentia as the realm of the ontologically real Possible, which he proposes is linked to the ontologically real Actual by quantum measurement in a new dualism. Kauffman’s proposal builds on Whitehead’s notion that reality is comprised of the realms of the Actual and the Possible, each of which gives rise to the other (Whitehead & Sherburne 1981).
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actions because they do not actually know what makes them behave or think as they do—i.e. there is usually no conscious process of evaluating stimuli prior to response (Nisbett & Wilson 1977). Indeed, neurological studies have found that 98% of what the brain does is non-conscious and without conscious guidance, and even our conscious reasoning is largely biased by the unconscious (Beratan 2007, citing others therein). Recent neuroscience research also calls into question the idea that the contents of our consciousness have matching neural representational systems (Noë & Thompson 2004), i.e. our brains do not appear to store conscious information.

An alternative to the mental model-dependent information processing view of learning, whereby learning occurs atomically within individuals, is the social constructivist view (see Appendix 4, Section A4.4.3), whereby learning occurs via the ongoing relationships and interactions between individuals (e.g. Gergen 1997; Shotter 1994). Stacey (2001) elaborates on the constructivist perspective with his complex responsive processes approach. This approach views minds and knowledge as being continually produced in an active process of relating—there is no storing or retrieving of information in mental models.

Maturana and Varela (1992) also reject the idea of knowing as grasping ‘facts’ about an objective world then storing them in our heads. Knowledge, or learning, is essentially ‘successful cognition’, whereby an organism couples with other systems without interruption to its own circular pattern of organisation (Maturana & Varela 1992). We presume to have gained knowledge whenever “we observe an effective (or adequate) behaviour in a given context” (Maturana & Varela 1992, p.174). The regularities we perceive in the world (i.e. knowledge) are simultaneously the result of both our social and biological histories, i.e. they are both biologically and socially constructed. Because we can never experience the world from an independent viewpoint, we can never be certain of our assertions about it (Maturana & Varela 1992), a notion which is consistent with the observer dependence of reality in a complexity-based ontology.

6.2.8 Social Construction of Reality

"Aboriginal Creation myths tell of the legendary totemic beings who had wandered over the continent in the Dreamtime, singing out the name of everything that crossed their path—birds, animals, plants, rocks, waterholes—and so singing the world into existence."

—Chatwin (1988)

Because cognition, in the Santiago sense, is understood as a process interacting with our environments (Maturana & Varela 1987), or the “effective action of a living being in its environment,”(p.27), then “every act of knowing brings forth a world” (p.26). As such, “all doing is knowing and all knowing is doing”, and we bring forth the world through our interactions with others (Maturana & Varela 1987, p.27). This pertains to the theories of social constructivists such as Shotter (1994), Gergen (1997) and Bakhtin (1986), who see mind, self and social phenomena as arising in the ongoing relations between people, rather than arising independently as ‘things’. For example, Shotter (1994) argues that there is no underlying objective reality; rather, reality is socially constructed.

Through their conversations, people both create and are created by their social reality (Shotter 1993, Gergen 1999). Shotter (1994) uses Prigogine’s work on dissipative structures (Appendix 3, Section A3.3) as an analogy. He states that while isolated systems progress towards increasing disorder—as per the second law of thermodynamics—open systems which are in continuous interaction with their surroundings progress towards increasing and often transformational order. These open systems not only become transformed, they also transform their environments, creating their own ecological niche to ensure their own maintenance (Shotter 1994).

Examples drawn from the traditional Inuit also demonstrate how other cultures understand and construct language and knowledge in contra-distinction to the Newtonian paradigm. Anthropologist Jean Briggs, in her interview with CBC radio (Kennedy 2011), notes that the Inuit are more concerned with the relationships between things than they are with ‘things’ themselves. One elder described words in a dictionary as ‘dead’, because for the Inuit, words without context
and personal experience have little use or meaning. That language somehow ‘dies’ when broken into words isolated from the relationships of their real-world context reflects the principles of emergence (Appendix 3) and the Theory of Logical Types (Appendix 2). It also echoes Capra’s (1997) observation that dissecting an organism reveals its parts but destroys the patterns of relationship that give it life. Closing-off a system from other systems (i.e. controlling ‘external’ variables) to reveal and control its cause-and-effect machinations leads to its ‘death’ via entropic disordering, as per classical thermodynamics.

Briggs further illustrates this idea by noting that from the Inuit perspective, if you want to know about ‘hunting’, you have to go out and hunt; you cannot have meaningful knowledge of it through reading or school. Likewise, you cannot know ‘cold’ unless you have experienced and had to contend with it in its various forms. This is related to the community-of-practice school of thought about how knowledge is constructed, and the limitations of transmitting explicit knowledge abstracted from its real-world context (e.g. Brown & Duguid 1991, see Appendix 4, Section A4.7.3). As such, Inuit traditionally do not teach their children by spoon-feeding them information; rather, they construct elaborate situations that enable their children to draw their own lessons from various life circumstances. For example, while working on an Inuit dictionary, Briggs spent days trying to learn the meaning of a particular word. Her Inuit collaborator would answer her repeated question with seemingly crazy responses, like “you’re sweeping the floor”, “you’re playing cards” or “company have arrived”. This went on for days before Briggs finally figured it out—the word meant ‘while waiting for it to cook’. Her Inuit colleague was describing the events that happen as people wait for a pot of food to boil (Kennedy 2011).

6.2.9 Dialogue, Power & Rhetoric

“The task consists of not—or no longer—treating discourses as groups of signs (signifying elements referring to contents or representations) but as practices that systematically form the objects of which they speak.”

—Foucault (1972)

Bakhtin (1986) likewise argues that all social phenomena are constructed through dialogue, in the ongoing relations between people. He states “Truth is not to be found inside the head of an individual person, it is born between people collectively searching for truth, in the process of their dialogic interaction” (p.110). Through dialogue novelty is produced, in an ongoing tension between converging forces of agreement and unity and diverging forces of disagreement and difference. This is consistent with Shotter’s (1994) rhetorical-responsive view of language, whereby he argues that everyday conversation is primarily composed of rhetoric—the arguments people use to persuade others to cooperate with them. Power relations determine whose rhetoric is expressed or suppressed, thereby dictating the emergence of official ideologies (Bakhtin 1986). The persuasive power of rhetoric is demonstrated by research showing that priming certain patterns of neuronal activation affects the cognitive outcome—for instance, how a question is asked and how alternatives are presented strongly affects decision outcomes (Beratan 2007, citing others), undermining the notion that people typically apply logical analysis when making decisions.

6.2.10 Problem Solving: Analysis vs. Insight

“The intuitive mind is a sacred gift and the rational mind is a faithful servant. We have created a society that honours the servant and has forgotten the gift.”

—Albert Einstein

Another frequently studied aspect of cognition is problem solving. Recent neuroscience research by Kounios et al. (2006) indicates that the brain has two problem solving modes: one that applies conscious, analytic reasoning using the left hemisphere, and the other which non-consciously and non-rationally arrives at a sudden insight, using the right hemisphere. In psychology, insight is said

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60 As opposed to representational-referential communication, which is cognitive in that it attempts to represent external reality that will be passively understood by others (Shotter 1994).

61 The role of right hemisphere thinking is to “simultaneously ‘capture’ an infinite number of connections and the formation of an integral but ambiguous context due to this capture ...the whole is not determined by its components,
to occur when the solution to a problem emerges suddenly and unexpectedly, in an ‘Aha!’ moment (Kounios et al. 2006, citing others therein). Watzlawick et al.’s (2011, see Appendix 4, Section A4.4.3) description of the spontaneous occurrence of second order change and its seemingly weird and paradoxical nature can be related to the phenomena of insight.

Kounios et al.’s work (2006) shows that creative individuals, having more diffuse attention that takes in a wider range of sensory inputs, are more likely to solve problems via insight. Conversely, less creative individuals, having a more narrow focus that takes in a smaller range of stimuli, are more likely to apply analytical search strategies to problem resolution. Their research also shows that the brain’s resting activity pattern determines which strategy an individual will use when presented with a problem. Insight and analytic strategies are suited to different types of problems (Kounios et al. 2006), and the brain’s right hemisphere plays a special role in solving insight problems (Bowden & Jung-Beeman 2003).

McGilchrist (2012) notes that the left hemisphere of the brain deals in discrete pieces of information, and provides precise, analytic and reductionist thinking. Conversely, the right hemisphere concerns itself with complex pattern recognition, surveying the wider environment (the big picture) for distant connections, integrating and channelling information, and providing holistic, insightful thinking and overall meaning (McGilchrist 2012). While the right side of the brain knows what the left is doing, the left hemisphere is rarely aware of what is going on in the right (McGilchrist 2012). Schooler et al. (1993) found insight-based problem solving can be impeded by asking subjects to verbally explain their thought-processes when given a problem to solve, which causes their brain activity to shift to the left hemisphere. Lehrer (2008, citing Jung-Beeman) suggests that complex tasks such as language require processing by both hemispheres so that the brain can “see the forest and the trees. The right hemisphere is what helps you see the forest.” (p.41).

Kounios et al. (2006) found that insight occurs after a period of intense focus and attempted problem-solving by the left-hemisphere, during a state of mental relaxation, disorganisation and openness that activates the right hemisphere and allows it to seek out remote connections needed for problem resolution. Bhattacharya (cited in Lehrer 2008) has likewise found that relaxation makes the brain more open to novel ideas and problem-resolution via insight. Whereas a relaxed, wandering mind can enhance insight, focus, stress and pressure to produce can eliminate its possibility—concentration diminishes creativity (Lehrer 2008, citing others). Schooler (1993) also notes that once insight suddenly emerges, the subject reacts both with surprise and certain recognition that they have found the problem’s solution, which now appears obvious. These findings mirror Ghiselin’s 1954 compilation of reflections by notable creative geniuses, among them the mathematicians Poincare, Whitehead, and Hadamard. These geniuses typically reported that their problem solving was not a product of purely conscious calculation; rather, they often had no idea what prompted the sudden appearance of their brilliant solutions (Nisbett & Wilson 1977). Alfred Whitehead described a “state of imaginative muddled suspense which precedes successful inductive generalization” (Ghiselin 1954, pp.4-5). Henri Poincare described his sudden insight into non-Euclidean geometry while boarding a bus:

At the moment when I put my foot on the step the idea came to me, without anything in my former thoughts seeming to have paved the way for it . . . I did not verify the idea; I should not have had the time, as, upon taking my seat in the omnibus, I went on with the conversation already commenced, but I felt a perfect certainty. (Ghiselin 1954, p.26)

These phenomena can be understood from the complexity perspective outlined in Chapter 5. Analysis, or conscious reasoning, works well when dealing with relatively simple problems. However, when dealing with complex, intractable, or wicked problems, making quantitative adjustments (e.g. doing more or less of the same) to the interactions between subsystems comprising the problem situation often perversely reinforces the higher order governing pattern since all specific features of the whole are determined only by interconnections between these parts” (Rotenberg & Arshavsky 1991, p.183)
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(i.e. the attractor) responsible for the undesirable situation. This may create a ‘game without end’ or a deadlock as per Galois’ Group Theory71 (Watzlawick et al. 2011). In addition, ascribing an incorrect logical type to a system’s pattern is likely to generate paradoxical situations such as vicious circles and double binds72, as per the Theory of Logical types73 (Watzlawick et al. 2011). Examples of this can be seen in the perversive incentives that unexpectedly emerge during economic or policy decision-making. It also explains Watzlawick et al.’s (2011) observations that onerous analysis typically fails to effect second order changes needed to resolve complex problems, and may indeed exacerbate the problem at hand. Argyris and Schön’s (1996) notion of single-loop learning can be understood as a form of analytical thinking, in that it involves adjusting existing behaviours without challenging a problem’s governing variables. This leads to ineffective first order change, which often causes problems to either fester or escalate74.

In contrast, creative, non-reductionist processes are more likely trigger insight into higher order patterns that are maintaining the problem situation, and present novel, qualitatively different solutions for transforming these patterns (i.e. transforming the system attractor), as per the Theory of Logical Types. To change the pattern of the system whole, a ‘jump’ to a qualitatively different, higher order pattern of behaviour is required, one that is not seen or recognisable at the subsystem level. This jump is of critical importance because it provides a route out of the system (Watzlawick et al. 2011). This is reflective of Argyris and Schön’s (1996) notion of double-loop learning, whereby a problem is addressed by altering its governing variables75, leading to second order change76. Perversely, however, attempts to logically invoke such a transformation in another individual often backfire, causing them to become defensive and entrench their existing pattern of behaviour (Argyris & Schön 1996), as per the theory of cognitive dissonance77 (Festinger 1957; see also Nyhan & Reifler 2010).

From the Santiago perspective we can see that analysis involves consciously imagining the cause-and-effect machinations of a problem. Because imagination is embodied, it triggers action on the basis of what we imagine, and in so doing may actually exacerbate the problem by ‘feeding’ the feedback loops that cybernetically generate and maintain the problem pattern. Parallels can be found in new understandings of neuroplasticity (Desde 2007; Schwartz & Beyette 1996), which propose that dysfunctional behaviours, such as obsessive and compulsive behaviour, arise when people are highly attentive to and over-analyse their problems, thereby paradoxically reinforcing the coherence of neural patterns that generate the problem behaviours by repeatedly activating them (Schwartz & Beyette 1996).

In consciously conjuring and analysing a problem in our imaginations, we also potentially retard our possible range of responses. This is because doing so necessarily pre-supposes a set of possible cause-and-effect relationships, thereby carving out a section of phase space to which the system (i.e. person) then tends to limit itself. By shifting brain activity to the left hemisphere, conscious analytic thinking gets in the way of a person having an unmediated experience of reality via their right hemisphere, which would otherwise open up the responsive possibilities posed by the entirety of the system’s phase space. Seeing a situation as a ‘problem’ to be analytically resolved, distances us from experiencing how reality is actually arising (Senge et al. 2004). Senge et al. (2004) believe this is related to the notion of suspension posited by Varela, whereby one removes oneself from one’s habitual stream of thought (Depraz et al. 2000). Suspension involves viewing our assumptions and thoughts at an arm’s length, allowing us to become aware of our thoughts so they have less influence on what we see. This allows us to ‘see our seeing’, so that we simply notice our thoughts, rather than holding tight to them (Senge et al. 2004). Bohm refers to this as “hanging our assumptions in front of us” (in Senge et al. 2004, p.29). In this way, suspension enables us to avoid

71 For details, refer to Appendix 2, and Appendix 4, Section A4.4.3.
72 For details, see Appendix 4, Section A4.4.1.
73 For details, see Appendix 2.
74 For details, see Appendix 4, Section A4.4.2.
75 Argyris and Schön (1996) regard these governing variables as values and assumptions in the form of ‘tacit mental models’. In the complexity view, these governing variables aren’t models—they’re habits, or patterns, of thought and action that form via repeated coupling between and individual and the systems that surround it.
76 For details, see Appendix 4, Section A4.4.2.
77 For details, see Appendix 4, Section A4.4.2.4.
imposing pre-existing mental frameworks and ‘groupthink’ on what we are seeing (Senge et al. 2004).

McGilchrist (2012) argues that Western culture has over-emphasised the conscious reasoning role of the left hemisphere at the expense of the right. As a result, we value precision and quantity over theory, creativity and quality, and have become more inward looking and neglectful of the ‘bigger picture’ and environmental influences. This contrasts with Eastern philosophies such as Buddhism, which are centred on ‘emptying’ the mind and breaking free of binding patterns of conscious thought.

### 6.3 Organisational Learning, Knowledge & Change

> “I claim not to have controlled events, but confess plainly that events have controlled me”
>  — Abraham Lincoln (1864)

Scholars have also applied notions of cognition, learning and knowledge to organisations. The field of organisational learning is a branch of organisational theory concerned with how organisations learn and adapt. The term was first used in 1965, after which its popularity grew dramatically (Crossan et al. 1999). Organisational learning draws from a wide range of disciplines, including anthropology, management science, computer science, human resource management, cognitive psychology, sociology and strategy (Easterby-Smith et al. 2004; Jashapara 2004), and has been applied to a number of different domains, including information processing, bounded rationality, and product innovation (Crossan et al. 1999). As such, a general theory of organisational learning has yet to be developed (Crossan et al. 1999). The field of organisational learning predates the more recent related literature around knowledge management and learning organisations and serves as a foundation for these emerging fields (Jashapara 2004).

The post-industrial economy is referred to by some scholars as the knowledge economy, as it is knowledge rather than craft and industrial technology that drive competitive performance of organisations (Jashapara 2004, citing others). As such, the fields of organisational learning and knowledge management have gained strength over the last 50 years as scholars and practitioners across at least 14 different disciplines concern themselves with issues around cognition, organizational learning and the effective sharing and application of knowledge (Valente & Rogers 1995).

Theories on organisational learning are largely drawn from theories of individual learning. As discussed in Section 6.2, and detailed in Appendix 4, Section A4.4, early learning theories were situated in the realm of behavioural psychology and focused on behavioural modification. Later works by Gregory Bateson (1958, 2000) added a cybernetic perspective that viewed behaviour and learning as the consequence of interactions and feedback loops between the learner and his or her environment. However, most organisational learning theories have their roots in cognitive psychology, and are therefore termed cognitive (e.g. Argyris & Schön 1974, 1996). The central tenet of these cognitive theories is a fixed external reality, which is represented and stored in the organisation via cybernetic processes. Senge’s (1991) concept of the learning organisation fuses organisational learning with Forrester’s work in systems dynamics78 (Forrester 1968, 1975, 1991), which is also based on cybernetics. Appendix 4, Section A4.5 provides a detailed review of these concepts.

The knowledge management literature, on the other hand, has its roots in the logical behaviourism espoused by Michael Polanyi and Gilbert Ryle in the 1950s and 60s (Jashapara 2004). It centres around notions of tacit and explicit and knowledge (Polanyi 1967), and knowing ‘how’ versus

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78 According to Forrester (1991), system dynamics broadly applies theory, methods and philosophy to analyse the behaviour of different kinds of systems, including environmental, economic, social, engineering, and medical. In particular, systems dynamics examines how things change through time: it looks to understand the behaviour of dynamic and complex systems by examining the internal feedback loops, time lags, and stocks and flows that affect overall system behaviour. This is done using cybernetic feedback control concepts to organise information about systems into computer models (Forrester 1991). Refer to Appendix 4, Section A4.3.4 for details.
knowing ‘what’ (Ryle 1984). Knowledge management has been of keen interest since the days of Taylor’s scientific management79, when industrial managers aimed to separate knowledge from workers as a scientific means of increasing industrial production and efficiency (Waring 1991). It is a young, multi-disciplinary field, concerned with the generation and sharing knowledge. Snowden (2003) describes three ages of knowledge management. In the first pre-1995 phase, mainstream theory and practice adopted the Newtonian notion of knowledge as a ‘thing’, awaiting scientific discovery. During this time, knowledge management focused on information technology applications for the structuring and flow of information to decision makers, i.e. information for decision support. The field was dominated by computer technologies, specifically in relation to cybernetic process re-engineering (Snowden 2003) and storing information on knowledge databases (Schutt 2003). As such, early knowledge management efforts were Tayloristic in their disregard for individual knowledge and capabilities (Schutt 2003) and the value of knowledge held and gained through experience (Snowden 2003). While valid in relation to manual tasks, this approach becomes problematic when dealing with ‘knowledge work’ (Drucker 1993), and the knowledge workers estimated to make up approximately 40% of the Fortune 500 workforce (Murray 1999, cited in Schutt 2003). According to Rasmus (2002, cited in Schutt 2003), approximately 80% of a company’s knowledge is personal knowledge of its employees.

Snowden (2003) describes the second age of knowledge management as the era when knowledge management as a discipline actually started. This phase of knowledge management focused on improving the productivity of knowledge workers, rather than just storing information on databases (Schutt 2003). It was sparked by the introduction of Nonaka and Takeuchi’s (1995) SECI model, with its focus on both explicit and tacit knowledge. This phase was largely characterised by the search for ways of transforming tacit knowledge into explicit knowledge and converting it into organisational asset. The third age of knowledge management is characterised by Stacey’s (2001) ideas around managing knowledge in complex adaptive systems. This approach goes beyond managing knowledge as a ‘thing’ that can be disembodied from the worker, to managing knowledge as a ‘flow’, and treats knowledge as an active process of relating (Snowden 2003). Complexity theory is now being applied by a number of knowledge management scholars as a means of better understanding how knowledge is generated, shared and applied in organisations (e.g. Kakihara & Sorensen 2002; McElroy 2000; Stacey 2001). For a more detailed overview of knowledge management concepts refer to Appendix 4, Section A4.6.

The organisational development and management fields (see Appendix 4, Section A4.3) have also been strongly influenced by Taylor’s scientific management and cybernetics. Corporate re-engineering, quality control and assurance, operations research and management, management cybernetics and total quality management all have their roots in scientific management (Khurana 2009). Likewise, industrial engineering and management, systems analysis, and systems management are rooted in cybernetics (Capra 1997). From the 1950s to the early 1980s, planned approaches to organisational change, as pioneered by the organisational development movement and its founding father, the cyberneticist and social psychologist Kurt Lewin, dominated the management field (Burnes 2005). Lewin devised action research and group dynamics, which together with his theories of planned change are the foundations of organisational development (Smith 2001a). Action research involves iterative cycles of collaborative planning, acting, then reflecting on results; these cycles are essentially cybernetic in that they are intended to be self-regulating (Lewin 1946). Planned approaches to organisational change focused on gradually improving organisational effectiveness using participatory team-based approaches (Burnes 2005). As was the case with Drucker’s management-by-objective approach (Appendix 4, Section A4.3.2), reductionist methods were applied through the development of organisational objectives and outcomes, with different parts of the organisation incrementally dealing with separate problems and goals one at a time (Burnes 2005).

In the 1960s, a more elaborate cybernetic approach to analysing and designing organisational processes was devised by Forrester (1968) in the form of system dynamics (refer to Appendix 4, Section A4.3.1 for details.

79 Taylor’s scientific management served to strip skill, or knowledge, away from workers, and relocate it within standardized practices and technology, such that expensive skilled workers could be replaced by mass production using cheap un-skilled labour (Schutt 2003; Waring 1991). See Appendix 4, Section A4.3.1 for details.
Section A4.3.4 for details). According to Stacey et al. (2000), this kind of systems thinking improved on understanding and managing organisations in three ways: 1) its emphasis on interaction and self-regulation; 2) identifying interconnections and indirect causal links distant in space; and 3) awareness that managers are part of the system and the importance of participation. Stacey et al. (2000) note that although systems approaches were innovative in their conception of organisations as non-linear entities regulated through feedback, they fell down by continuing to treat organisations as closed systems near equilibrium, and by failing to address the phenomena of spontaneous self-organisation—the emergent behaviour that characterises complex systems such as organisations, as per theories outlined in Appendix 3. Thus, until the 1980s organisations were largely regarded as relatively static entities, at or near stable equilibrium, and flexibility and rapid responsiveness were not considered critical for their success (Levy 2000).

In the late 1960s, however, organisational scholars had begun to seize on ideas from the newly emerging complexity sciences (Anderson 1999), both in terms of metaphor for gaining new insights into organisational behaviour, and as a means of mathematically modelling how organisations operate (Burnes 2005). For example, in 1967 Thompson described complex organisations as being wholes interdependent with their external environments and comprised of sets of interdependent parts (1967, cited in Anderson 1999). Burnes (2005) notes that after 1970s’ oil shocks and Western economic recessions, the limitations of planned approaches for generating the rapid and radical organisational change needed to survive in a fast paced new world had become apparent. Thus, from the 1980s, management researchers began to conceptualise organisational change as a process of punctuated equilibrium80, as per challenges to Darwin’s gradualist model of evolution in the natural sciences, or as a process of continuous transformational change, as per ideas from the emerging complexity sciences (Burnes 2005). As a result, a number of new approaches to organisational change, which Weick (1979) lumps under the umbrella term ‘emergent change’, began to appear81. Among them were Checkland’s (1981) soft systems methodology, Weick’s (1979) organisational sense-making, and Stacey’s (2001) complex responsive processes. Organisational researchers also began applying complexity ideas as a means of finding new ways of strategically manipulating organisations, such as enabling evolution of self-organised solutions to problems, altering fitness landscapes for local agents, and reconfiguring or ‘tuning’ organisational architecture to promote adaptation and innovation (Anderson 1999; Levy 2000). A more detailed overview of these concepts can be referred to in Appendix 4, Section A4.3.5.

In the sections that follow, I discuss theories of organisational learning, organisational behaviour and knowledge management in relation to how they have been traditionally understood from a Newtonian perspective, whereby organisations are regarded as information-processing ‘things’, and how they can be alternatively understood from a complexity perspective, whereby organisations are regarded as patterns of interaction, i.e. extensions of cognition in the Santiago sense (as per Section 6.2).

6.3.1 Traditional Cognitive View of Organisational Learning

As noted above, the field of organisational learning is largely premised on traditional cognitivist views that people build mental models representing reality and store them in their minds. As such, Stacey et al. (2000) state that organisational learning theories are built on the following string of assumptions: 1) knowing and acting is centred in the individual, 2) all individuals have similar brain structures and their brains process the same external reality, and 3) hence, there is no problem with individuals sharing the same perceptions. As a result, organisational learning scholars frequently refer to organisations as having an organisational schemata (Bartunek & Moch 1987), or theory-in-use (Argyris & Schön 1996), which is the equivalent of an individual’s mental model—they are meanings or frames of reference shared by an organisation’s members.

Clearly, given its Newtonian assumptions, this understanding of organisation learning is not supported by the complexity-based ontology outlined in Chapter 5. However, by regarding human

80 Periods of gradual change punctuated by short periods of rapid transformational change.
81 Weick (1979) describes emergent change as the unplanned, unintentional adaptations and adjustments that organisational members make in their day-to-day work routines.
organisation and all other social phenomena as extensions of cognition in the Santiago sense, as described in the previous section, we can explain organisational behaviour in a way that is consistent with a complexity-based ontology. In so doing, we can also resolve some of the paradoxes created by the traditional cognitive view of organisational learning and behaviour. This extended (Santiago) cognition-based understanding of organisations is consistent with Stacey’s complexity approach to organisational management (Stacey 1996a, 2001; Stacey et al. 2000), and Shotter’s (1994) constructivist views on social phenomena. Stacey posits that the complexity sciences can provide a more coherent theoretical framework for understanding organisational behaviour. In particular, Stacey et al. (2000) advocate a view of organisations as self-organising, complex adaptive systems, as described in the works of selected complexity scientists, namely Prigogine (1997) and Kauffman (1993) (see Appendix 3 for details). Shotter’s constructivist perspectives are premised on the work of social psychologists from the 1920s and 30s, namely Mead (1934), Vygotsky (1962) and Bakhtin (1986), who held the view that mind and self are not pre-existing; rather, they emerge in social relationship and are an internalisation of these relationships (Stacey et al. 2000). In the sections below a synthesis of these theories will be discussed in comparison with the traditional view of organisations in the organisational learning literature, and in relation to the complexity-based ontology proposed above.

6.3.2 What is an Organisation?

In the traditional cognitivist view an organisation is typically regarded as a ‘thing’. Popper and Lipshitz (1998), for example, state “a collective becomes an organization once it develops procedures and structures (e.g. voting rules and management systems) that allow it to act as a unit” (p.170). Likewise, Argyris and Schön (1996) state that rule-making is what brings an organisation into being.

In the proposed complexity-based ontology, however, an organisation is understood autopoietically as higher order unifying (circular) patterns emerging from the interactions of its members and shaped by its couplings with other systems, as per the Santiago theory of cognition (Maturana & Varela 1980, 1992) and the dynamical systems or enacted view of cognition (Varela et al. 1991). Through its interactions, an organisation both shapes and is shaped by its members. It also simultaneously shapes and is shaped by other systems that comprise its environment. In other words, members are continuously working (mostly unconsciously) to maintain their own identities (i.e. circular organisation/pattern of behaviour) while interacting with other members (via their own patterns of behaviour), from which the larger governing pattern of the organisation itself emerges (the organisational identity). This larger governing pattern then exerts a downward governing pattern on its members, which harmonises their interactions in ways that maintain the larger organisational pattern/identity. It also interacts with the governing patterns of other systems.

While the traditional organisational learning view understands organisations as having ‘routines’, which are described as dynamic patterns of behaviour (Jashapara 2004), in the complexity view, the organisation is these dynamic patterns of behaviour. Likewise, the term organisational culture, is just another way of describing persistent patterns of interaction that are the organisation. Organisational routines are seen to accumulate during periods of stability (Jashapara 2004; Pentland & Rueter 1994). This is understandable from a complexity perspective, because circular organisation tends to become more cohesive with repeated iteration, self-referentially strengthening its own pattern, or identity. However, as per chaos theory (Appendix 3, Section A3.5), with sufficient iterations an organisational pattern may become unstable (due to amplification of small effects) and transform into a higher and more complex dimension of order, or alternatively collapse into disorder. Generally speaking, however, self-organising systems tend to move toward higher dimensions of order, and become increasingly complex as a result (Kauffman 1993).

This understanding is similar to Stacey’s (2001) view of organisations as complex responsive processes—patterns of everyday interaction between people, or the temporal processes of human relating. Stacey’s perspective does not abstract people from their interactions in that it does not regard the product of their interaction as being a ‘system’, i.e. some external ‘thing’. Rather, the product of their interaction is simply more interaction between people. These iterative processes of relating
are simultaneously cooperative and conflicting, and subject to power differentials between organisational members. It is through these everyday processes of relating that people in organisations cope with uncertainty and perpetually co-create the future together (Stacey 2001). Thus, from a complexity perspective, an organisation is seen as a coherent pattern of interactions co-creating reality with other systems (which themselves are just dynamic patterns of interaction), rather than as a ‘thing’ or a system of things moving about in a pre-given external reality.

6.3.3 Organisational learning

Casey (2005) defines organisational learning as a social process involving both behaviour change and knowledge creation (cognition), with the intention being increased capacity to survive. Argyris and Schön (1996) define organisational learning as an “active process of organising which is, at its root, a cognitive enterprise” (p.16-17). In keeping with the traditional view of cognition, Argyris and Schön (1996) suggest that organisations have theories-in-use, which are formed from the collective mental models their members use to understand the organisation and how they fit into it. The organisation’s theory-in-use is responsible for governing its behaviour, and, as noted above, is essentially its mental model or schemata of reality. Organisational learning happens when a mismatch occurs between the actual and expected results of an action, and a member enquires into it on the organisation’s behalf (Argyris & Schön 1996). Hence, organisational learning occurs by way of information processing, as feedback transforms these organisational theories-in-use, cybernetically closing the gap between external reality and its representation in the minds of organisational members.

While Argyris and Schön’s understanding of an organisation as an active process is consistent with the complexity perspective, it is inconsistent in its reliance on mental models. If one dispenses with the assumption that cognition is matter of information processing using mental models, as does the Santiago theory of cognition, then attempting to insert ‘mental models’ into the process of organisational learning, as Argyris and Schön do, is unnecessary. The organisation is its pattern of behaviour, which is functionally equivalent to its theory-in-use, but without circuitous reference to a theory or model.

Because most organisational learning scholars attempt to reconcile the notion of organisational learning with mental models, their criteria for what constitutes organisational learning includes two elements: 1) behavioural change that represents a change in the organisation’s theory-in-use (i.e. mental model); and 2) demonstration that the knowledge acquired through learning has been ‘embodied’ in the organisation in the form of artefacts such as memories, policies, and procedures. (Argyris & Schön 1996). These artefacts are regarded as the equivalent of an organisational nervous system, and serve to ‘store’ the organisation’s mental model and knowledge (Argyris & Schön 1996). This creates the paradox whereby the organisation is considered both a representation of knowledge (in its behaviours) and a container of knowledge (in its artefacts), thus both a ‘process’ and a ‘thing’ (Lipshitz 2000). It also begs the question of how learning at the individual level is transformed into learning at the organisational level (Lipshitz 2000).

From a complexity perspective, however, the notion of mental models is both an unnecessary complication, as described above, and an error in logical typing, as outlined in the discussion around cognition in the previous section. Cognition, communication, consciousness, imagining, dialogue, learning, organising, and all other social phenomena, are simply ascending and nested dimensions of order emerging from increasingly complex patterns of interaction—i.e. they are the same process, just at different levels of complexity. All living systems are perpetually learning, transforming themselves with every interaction.

Thus, an organisation is likewise understood to be continuously learning by virtue of its definition, in its continuous interactions with other systems (as per Maturana & Varela 1992). As such, learning at the organisational level does not require physical manifestations in the form of artefacts—it is evident in the ongoing patterns of interaction that constitute the organisation’s day-to-day behaviour. As is the case at the individual level, organisational learning is seen as successful interaction, whereby the organisation interacts with other systems without disrupting its circular
pattern of organisation/identity. This is an adjustment to the traditional Newtonian idea of an organisation *adapting* to its environment, which assumes a background world to which the organisation, as an autonomous entity, must adapt. From a complexity-based perspective, the organisation can be understood as *co-creating the world* with other entities, rather than *adapting to a world* and competing with other entities for a space in it. This complexity view nonetheless maintains a strong ‘survival’ element, as each organisational entity works to maintain its circular organisation/identity while interacting with others, a process subject to power relations, conflict and cooperation (see Bhakin 1986).

It is also inappropriate to think of policies, procedures and other artefacts as being the equivalent of an organisational nervous system where knowledge is stored. This is because the role of a nervous system is *not* storing information, as previously understood by the traditional information-processing view of cognition. Rather, the role of the nervous system is increasing the number and complexity of interactions an organism can enter into, therefore expanding the organism’s domain of possible behaviours, as per the Santiago view of cognition. As such, gossip at morning tea, email and the Internet (as a means of interacting) would be better analogues for an organisational nervous system.

Lipshitz (2000) argues that the view of organisations as both representations of knowledge and as containers of knowledge, reflects a fundamental duality in organisational learning. As such, organisational learning is viewed as *learning-in organisation* (individual members of the organisation learn, via training, etc.), as well as *learning-by organisation* (learning that manifests in procedures, policy, culture, etc.) (Lipshitz 2000). So although an organisation learns through its members, what it ‘knows’ is greater (and sometimes less) than the sum of what its members know (Argyris & Schön 1996). Lipshitz (2000)—not believing it is self-evident that organizations can learn—sees this “anthropomorphic” view of organisational learning as a paradox that raises the question: if organisations do indeed learn through their members, how is learning at the individual level transformed into learning at the organisational level?

Understanding learning as an extension of cognition in the Santiago sense resolves this question. The transformation takes place via emergence, when the interactions of individuals self-organise into a higher order unifying pattern constituting the organisation. Because an organisation is of a higher logical order than its members, its behaviours and learnings are not simply a sum of that of its members. Rather, they are emergent, and therefore qualitatively different to that of its members. In other words, an organisation will learn and behave in ways that cannot be predicted from the learning and behaviour of its members. To assume so would be an error in logical typing.

Thus, from a complexity-based understanding, knowledge *is* learning; it is an active process of relating, not a *product* of learning. In sum, it is a *process of co-creating reality* with other entities, rather than a *representation of external reality*. If knowledge is no longer regarded as a ‘thing’, it can be neither a representation of an organisation (rather, it *is* the organisation—a dynamic pattern of interaction), nor contained within organisation. Again, this is consistent with Stacey’s complex responsive processes approach, which sees minds and knowledge as being continually produced in an active process of relating; there is no storing or retrieving of information in mental models (Stacey 2001).

The concept of communities-of-practice (Appendix 4, Section A4.7)—whereby learning is seen to be socially constructed in the relationships between people (e.g. Lave & Wenger 2001; Wenger 1998)—is more in line with a complexity based understanding of organisational learning than is the traditional cognitive perspective. In the communities-of-practice view, training and other methods that isolate knowledge from practice or abstract it from the knower (e.g. office procedures) are regarded as ineffective vehicles for learning (Brown & Duguid 1991).

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82 Although one could argue that entrenched/coherent patterns of interaction can be understood to store knowledge, which in this sense could thus be considered a ‘thing’.
6.3.3.1 Complexity Responses to Central Questions in Organisational Learning Literature

A complexity-based understanding of organisations, as outlined above, can then be used to answer the central questions scholars are concerned with in the field of organisational learning, as outlined by Argyris and Schön (1996, p.xx). I have supplied my responses to their questions in italics:

1. What is an organisation that it may learn? *It is a dynamic circular pattern of relationship (i.e. organisation) emerging from the interactions of its members, directing the interactions of its members, and being shaped by its couplings with other systems.*

2. In what ways, if at all, are real-world organisations capable of learning? *The organisation learns every time it couples with other systems without disrupting its own circular pattern of organisation, or identity.*

3. Among the kinds of learning of which organisations are, or might become capable, which ones are desirable? *The only learning an organisation ‘strives’ for is that which maintains its circular organisation, or identity. Any other value attributed to learning is entirely subjective and observer dependent.*

4. By what means can organisations develop their capability for the kinds of learning they consider desirable? *An organisation’s behavior will become more plastic (responsive and novel) as the number and complexity of interactions it and its agents enter into increase. However, it is not possible for one individual or group thereof to dictate what behavior patterns emerge as a result.*

This complexity-based understanding can also be applied (in italics) to the frequently launched academic challenges outlined by Argyris and Schön (1996, p.xx), which:

1. Argue that the very idea of organisational learning is “contradictory paradoxical, or devoid of meaning”. *The notion of organisational learning is no longer paradoxical if one abandons the belief that learning is mediated by mental models of an external reality, and opts instead for the Santiago perspective, whereby all living systems are cognitive (i.e. learning) systems by virtue of their interactions.*

2. Accept the notion of organisational learning, but doubt that real-world organisations actually engage in organisational learning, or are capable of it. *As above.*

3. Accept that real-world organisations learn, but deny that organisational learning is always or ever beneficial. *The only learning an organisation ‘strives’ for is that which maintains its circular organisation, or identity. Any other value attributed to learning is entirely subjective and observer dependent.*

From a complexity-based understanding, all of the arguments summarised by Popper and Lipshitz (1998) about treating organisational learning as an extension of individual learning apply, with my caveats noted in italics.

1. Organisations have cognitive systems that enable them to perceive, think, reflect, and so on, which are similar to, although not identical with, those possessed by individuals” (p.163-164). *While a human organisation can be understood as being aware, as are all organisms, reflection requires self-awareness (meta-awareness, or consciousness), which only occurs in higher animals and may not be present in human organisations*. Thus, double-loop learning at the level of the organisation (as opposed to individual organisational members) is unlikely, as it would require that the organisation possess self-consciousness to reflect on itself and its governing premises.

2. Organisations do learn, but their learning is mediated by the learning of their individual members (p.164). *Although learning is mediated by individuals because the organisation is an emergent*
property of their interactions; learning also occurs at the level of organisation in its interactions as a higher order entity.

3. Similar to individuals, organisations are capable of learning; however, the individual learning and organisational learning differ fundamentally (p.164-165).

4. Granted that learning produces knowledge, organisations and their members often know, or come to know, different things (organisations may know more or less than their individual members) (p.165). Recognising that knowledge is a pattern of interaction rather than a ‘thing’, i.e. knowledge is learning in the Santiago sense.

6.3.4 Organisational Persistence

A complexity-based understanding can also help explain why the attempts at bringing about organisational change so often fail (as per Burnes 2005; Senge et al. 1999), as discussed in Chapter 1. Once a circular pattern of organisation has become established, it is self-reinforcing and serves only to maintain itself, typically becoming more entrenched over time. This feature of complex self-organising systems explains why organisational members become attached to patterns of behaviour that— from management’s perspective— have outlived their effectiveness (as per Levitt & March 1988). It also explains why people resist double-loop learning, and become defensive when changes to entrenched organisational patterns are attempted (as per Argyris & Schön 1996, see Appendix 4, Section A4.5.4). In addition, it bears upon Stacey’s (1996a) notion of the shadow organisation, which represents the actual behaviour of an organisation, as opposed to how it is supposed to behave from a managerial perspective.

6.3.5 The Shadow Organisation

“I ought to be thy Adam, but I am rather the fallen angel...”
—Mary Shelley, Frankenstein (1823)

Stacey (1996a) observes that all organisations carry out a set of primary tasks via the cooperative efforts of their members— this is the purpose of an organisation’s formal, or legitimate, system, which consists of its official policies, procedures, organisational hierarchy, budgets and job titles, all of which tend to be rational, explicit and written down. However, running parallel to this formal system is the organisation’s shadow side: the “disagreeable, messy, crazy and opaque aspects of your organisation’s personality” (Tate 2005, p.22). The shadow organisation consists of all the real-time social and political interactions that occur outside the organisation’s formal system (Stacey 1996). Elements of this shadow system include: trust, friendships, ambition, jealousy, fear, insecurity, power struggles, and gossip (Tate 2005). Whereas an organisation’s formal system is organised by those in authority, the shadow system is dynamic, self-organising, tacit and obscure; it is political and is often undiscussed or un-discussable (Tate 2005, citing others). The shadow organisation has a life of its own. It is self-serving, governed by the collective personal needs of its members (Stacey 1996a). It can be chaotic, but also very resistant to change, sabotaging any attempts to alter the status quo (Stacey 1996a).

From a complexity perspective, this means that an organisation may realistically “traverse a substantial phase space around an attractor, which may represent multiple organisational states” far from its formal mission and goals (Levy 2000, p.82). The shadow system is often the source of an organisation’s failure to efficiently deliver on its mandate (Tate 2005). This is particularly the case when an organisation’s shadow system is widely out of alignment with its formal system. On the flip side, the shadow system is the organisation’s fount of creativity and innovation (Tate 2005). Because the shadow system is where things really happen in an organisation (as opposed to where/how they’re designed to happen), when the formal system becomes overly bureaucratic or dysfunctional the shadow system can deliver outcomes in spite of it (Tate 2005). Stacey (1996a) suggests that the shadow system is the generator of the mess and disorder needed for learning and ensuring a system doesn’t become ‘ossified’. As such, Tate (2005) argues that any change initiative that fails to gain the support of the shadow organisation will likely fail.
6.3.6 The Hopeful Map

“Accursed creator! Why did you form a monster so hideous that even you turned from me in disgust?”
—Mary Shelley, Frankenstein (1823)

This idea of an organisation having two such sides is also reflected in Argyris and Schön’s (1996) notion of an organisation having both an espoused theory of action and an actual theory-in-use (Appendix 4, Section A4.5.1)—the theory-in-use being equivalent to the organisation’s shadow system, or actual behaviour, and the espoused theory being equivalent to the organisation’s legitimate system. Indeed, the formal system, or espoused theory, can be understood metaphorically as a hopeful map: a ‘map’ in that it is an abstraction used to describe the ‘territory’ (the actual pattern of interactions that constitute the organisations), and ‘hopeful’ in that it describes how managers have presumed or intended that territory. The ‘shadow organisation’ and ‘theory-in-use’ concepts capture the understanding that our ‘maps’ are often widely out of alignment with the territory they’re meant to represent. In the case of organisations, the misalignment is due to our underlying Newtonian assumptions that complex self-organising systems are ‘things’ predictably subject to cause-and-effect, and which can therefore be designed and controlled to meet externally designated purposes. And when a formal system does not work as designed—and indeed begins to create new problems or exacerbate the ones it was designed to solve—we—the organisation’s members are stuck with it, making ordinary every day decisions to work around it and still get things done (Stacey et al. 2000). This calls to mind the local population in Shelley’s 1818 novel, who were left to deal with Frankenstein’s ‘hopeful monster’, the product of the doctor’s disastrously well-intentioned attempt at designing and engineering a human being.

Stacey’s notion of the shadow system resonates in the maxim of the famed cyberneticist Stafford Beer (2002): “the purpose of the system is what it does”. This reflects his observation that a system’s effective purpose is often far removed from its official purpose. Thus, if the purpose of a system is what it does, then the ‘purpose’ of an organisation, or any other system, is inevitably emergent (the result of the interactions between its components and with other systems), rather than prescribed by some entity or authority standing outside of it. In this sense, ‘purpose’ really means ‘pattern’, or habit, and is an inappropriate term in relation to self-organising systems, as it is teleological in its implication of design, intention and/or fate.

6.3.7 Organisational Change

“Prometheus, then, took over the task of creation and thought out a way to make mankind superior. He fashioned them in a nobler shape than the animals, upright like the gods”
—Hesiod (as told by Hamilton, 1942)

The problem solving discussion earlier in this chapter (in Section 6.2.10) can also be directly applied when thinking about change in organisations. Because organisations are circular self-reinforcing patterns of interaction, trying to solve organisational problems analytically—by making quantitative adjustments to the interactions between the organisation’s members (doing more or less of the same)—tends only to effect first order change (as per Watzlawick et al. 2011). First order change reinforces the existing pattern of the organisation, and therefore perpetuates the problem at hand, as per Galois’ Group Theory, and Argyris and Schön’s (1996) single-loop learning. However, any prescribed attempts at changing the higher order governing pattern of the organisation, i.e. second order change, will likely be greeted with resistance and distrust, as members defensively mobilise to ‘snuff out’ threatening changes, as per Stacey’s (1996a) notion of ‘organisational antibodies’. This effect has been likewise described in relation to double-loop learning (Argyris & Schön 1996), cognitive backfire (Nyhan & Reifler 2010), learning organisations (Senge 1990), and systems dynamics (Meadows 1999) (see Appendix 4 for details). Senge (1990), for example, notes that people have the capacity for double-loop learning, but are constrained by their organisations. Indeed, instigating second order change likely becomes more difficult as an organisation becomes

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84 Refer to Appendix 4, Section A4.5.4 for details on the counterproductive anti-learning patterns of Model I organisations, which are characterised by “defensiveness, self-fulfilling prophecies, self-fuelling processes, and escalating error” (Argyris 1982, p.8).
more complex, due to it becoming controlled by a higher-order governance pattern that is far beyond any individual’s control.

As a means of countering this effect, Lipshitz (2000), Argyris and Schön (1996) and Visser (2007) all put forward the notion of organisational meta-learning, whereby organisational members learn to reflect on an organisation’s schemata as a means of detecting and correcting errors and effecting second order change. However, from a complexity perspective this is a case of confusing logical types. Organisational meta-learning is not possible at level of individuals—consciousness and some form of meta-communication (language) would be required at the organisational scale.

Nor is it likely that resistance can be overcome by increasing managerial control. Because the organisation’s governing pattern emerges from a multitude of interactions between its members and other systems, the actions of one or a few people in management—even if they hold disproportionate power—are unlikely to effect the desired change. According to Richardson (2005), change from within a system is emergent and inevitable, whereas change from without is the result of outside perturbations. The two, however, are interdependent (Richardson 2005), and, in any case, change is very difficult to predict and sometimes undesirable:

The overall system’s behaviour might be radically affected, or the system might absorb any attempt to change and continue relatively unaffected. Though, it is important to remember that attempts to change the system (failed or not) may result in delayed changes despite no apparent immediate reaction. Who knows what chain of events might have been triggered. (Richardson 2005, p.624)

Indeed, managerial attempts to ‘fix’ certain organisational behaviours may actually create serious problems, such as vicious circles, perverse effects and deadlocks, where issues were previously mild or non-existent (as per Watzlawick et al. 2011). This is similarly observed by Meadows (1999, see Appendix 4, Section A4.3.4), who states that managers have difficulty discerning which way to push system ‘levers’ to effect desired organisational change. According to Meadows, leverage points are frequently counterintuitive, and worsen the situation if pushed in the wrong direction.

As such, Bartunek and Moch’s (1987) assertion that people can be trained to induce first, second or third order change (see Appendix 4, Section A4.5.11) seems problematic, given the deep complexity of dynamic interactions that are involved in creating a pattern of organisational behaviour to begin with, and the uniqueness of every organisation. Despite this assertion, Bartunek and Moch (1987) observe that second order change usually only occurs ‘naturally’ (i.e. spontaneously), and often in response to a crisis which ‘unfreezes’ the existing organisational schemata. Numerous other authors have likewise indicated that crisis, or some form of organisational ‘unlearning’, is usually needed to precipitate double-loop learning and second order change (Argyris & Schön 1996; Nystrom & Starbuck 1984; Watzlawick et al. 2011). Indeed, Bartunek and Moch (1987) even go so far as to suggest that change agents attempt to precipitate a crisis in order to prime an organisation for second order change.

This phenomenon makes sense when viewed from a complexity perspective. Self-organising agents in a complex system simultaneously and paradoxically bring forth both persistence, due to constraints imposed by coupling with past states and shared histories with other systems—and potential transformation, due to amplifying feedback and spontaneous emergence of novel behaviours. As a system in crisis becomes increasingly unstable, i.e. approaches the edge of chaos (Kauffman 1993), it becomes sensitive to amplification of small effects, poised the system for radical transformational change, or collapse into disorder (Appendix 3). This paradoxical situation is reflected in the Mandarin symbol for crisis, which is comprised of two characters, one representing danger, the other representing opportunity.

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85 Ibid. 83, p.144.
86 Although this meaning has been disputed as a misconception by some language scholars (e.g. Mair 2009).
Stacey (1996a) discusses this aspect of human organisations in relation Kauffman’s (1993) NK models of complex self-organising systems (refer to Appendix 3, Section A3.6.2 for details). When connectivity, diversity and rates of information flow between their members and/or outside groups are low, organisations are relatively stable and unchanging. These organisations require little energy or information flow to sustain themselves; however they are not really learning or adapting because existing patterns of connection have ‘locked-in’, or ossified (Seel 2006). In order for an ‘ossified’ organisation to become receptive to change, connectivity, diversity and rates of information flow between people need to increase. This begins to destabilise the organization, causing it to spontaneously become more responsive and adaptive to its environment (Stacey 1996a). In doing so, novel patterns of organisational behaviour (i.e. new basins of attraction) may begin to emerge. However, in the case of too much connectivity, the organisation may alternatively be driven to collapse (Stacey 1996a).

For example, Tan’s (2013) review of organisational change shows that organisations with a more diverse workforce have better problem-solving skills and can understand and penetrate more markets; however, it also notes that too much workforce diversity can also create confusion and chaos. Maintaining existing patterns of behaviour that exploit old certainties are beneficial when an organization is operating in a relatively stable environment (Holland 1975; March 1991). However, in rapidly changing and unpredictable (i.e. turbulent) environments, hanging onto old patterns can be detrimental, and the organization must become more responsive to exploring and adapting to new possibilities if it is to survive (Holland 1975; March 1991). This explains why solutions are short lived in dynamic environments (Lipshitz 2000), and why stable solutions breed new problems (e.g. Allison & Hobbs 2006; Bartunek & Moch 1987; Berkes & Turner 2006).

6.3.8 Challenge to Paradigm of Managerial Control

“You are my creator, but I am your master; Obey!”
—Mary Shelley, Frankenstein (1823)

Stacey et al. (2000) posit that today’s organisational management is premised on scientific management (i.e. Taylorism) and systems thinking. They state that this has led to a Newtonian view that organisations are ‘mechanisms’ (in the case of Taylor, Drucker, etc.), or self-regulating systems that have been externally engineered (in the case of Forrester, Argyris & Schön, Nonaka & Takeuchi, Senge, etc.), which can be studied to reveal the cause-and-effect laws that govern their behaviour. It has also led to the view that managers and researchers stand outside their organisations as objective observers (Stacey et al. 2000). Armed with the correct information, managers have the power (by designing rules, procedures, strategies, etc.) to manipulate and control organisations to achieve chosen goals and induce optimal patterns of behaviour—as such, the manager is the ‘scientist’, and the organisation is the ‘phenomenon’ under study (Stacey et al. 2000). Stacey et al. (2000) criticise research treating organisations as networks or systems (e.g. systems dynamics) as being largely reductionist. The systems view is concerned with control. It typically assumes the presence of an observer or group of observers (i.e. managers or researchers) who delineate or design the organisational system, or who determine the rules of interaction for its component parts, while neglecting the role of workers’ free choice in shaping the organisation (Stacey et al. 2000).

Stacey et al. (2000) argue that these deep-seated Newtonian assumptions are why managers so often feel they are in charge but not in control, why the systems they design hardly ever work, and why planned attempts at organisational change are so often met with frustration. Stacey et al. (2000) state that as soon as some system mechanism for the organisation has been identified and described, the organisation has moved on. Designed systems, rules and procedures cannot cope with all eventualities and the pace of the change; these tools rely on stability and are no longer functional in a turbulent world (Stacey et al. 2000). Contrary to mainstream organisational thinking, Stacey et al. (2000) make the following arguments: uncertainty is inescapable and success can never be guaranteed; cooperation is more important than competition; no individuals, including managers, have the power to control or design organisational change; efficiency destroys organisational stability; diversity and conflict foster innovation; potential success lies in co-existent
stability and instability; and organisations are driven by their need to express identity rather than profit or competitiveness (Table 6.1).

Table 6.1. A comparison of how organisations are understood from a complexity perspective versus the dominant management discourse (Stacey et al. 2000).

<table>
<thead>
<tr>
<th>Organisations as complex systems</th>
<th>Dominant Management Discourse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Long-term predictability of complex organisational processes is severely limited, because emergent behaviours in complex systems cannot be predicted in advance. Creativity and uncertainty are linked</td>
<td>1. The manager’s role is to reduce uncertainty</td>
</tr>
<tr>
<td>2. Transformational change in organisations occurs via the dynamic self-organising interactions of their members. Creativity occurs through cooperative relationships and the constraints imposed on these relationships by power, politics and conflict</td>
<td>2. Competition is more important than cooperation</td>
</tr>
<tr>
<td>3. There are limits to individual choice. The organisation’s creative future is the unpredictable result of the dynamics of interaction rather than the choice of individuals and small groups.</td>
<td>3. Managers have the power to choose and control their organisation’s future</td>
</tr>
<tr>
<td>4. Organisational stability results from the conflicting constraints (power) imposed by relationships, redundancy, and operating at the edge of chaos, where extinction events tend to be small</td>
<td>4. Efficiency and managerial control are sources of organisational stability</td>
</tr>
<tr>
<td>5. Diversity and difference are sources of organizational novelty</td>
<td>5. Harmony and consensus need to be emphasised</td>
</tr>
<tr>
<td>6. Ability to plan and design change is limited. Organisations have internal capacity to change spontaneously. Change cannot be designed, planned or optimized</td>
<td>6. Management’s role is to design and plan for optimal outcomes</td>
</tr>
<tr>
<td>7. Organisations have the potential (not guarantee) to succeed and change in novel ways when they are simultaneously stable and unstable</td>
<td>7. Success is equated with stability</td>
</tr>
<tr>
<td>8. Organisations and their members are driven by their need to express their identity and difference. Goals relating to profit and competitiveness are subservient to this need</td>
<td>8. Performance is the all-important motivating force behind an organisation</td>
</tr>
</tbody>
</table>

According to Stacey et al. (2000), what can cope with a turbulent world are the organisation’s people, as they have the capacity to exercise free will and adapt to changing circumstances. Indeed, an organisation is people, and managers are among those people—hence the reason why organisations get things done anyways, despite the failures of their plans and strategies to achieve intended outcomes. Organisational change is not caused by chance or managerial decisions. Rather, it emerges from the interactions and relationships between people in the organisation (Stacey et al. 2000). The authors further suggest that:

The notion that managers can choose what happens is so deeply ingrained that it leads to the typical response that if they can’t choose outcomes, at least they can choose the numbers and strengths of connections, the qualities of relationship that produce the dynamics of edge of chaos where creative change is possible. However, this misses the point, because no agent is choosing the numbers or strengths of connections for other
agents in the system, or for themselves either; even if they were, this is not enough to determine the dynamic. (pp.112-113)

Stacey et al. (2000) and Shackley et al. (1996) challenge organisational researchers who view complexity ideas as a means of finding new ways to strategically manipulate organisations—such as enabling evolution of self-organised solutions to problems, altering fitness landscapes for local agents, and reconfiguring or ‘tuning’ organisational architecture to promote adaptation (Anderson 1999). Levy (2000) likewise cautions that the idea that organisations can be ‘tuned’ to be more innovative is problematic, and questions whether it is possible to know when an organisation is on the edge of chaos, or what control parameters can be adjusted to get it there. Specifically, Stacey et al. (2000) dispute a number of assumptions held by other complexity management writers, namely that managers can: 1) select simple rules that will create the desired pattern of outcomes; 2) create harmony and sharing in an organisation (which ignores the role of conflicting constraints in organisational creativity and stability); and 3) learn how complex systems are ordered then use this information to manipulate the system. They argue that attempting to apply these assumptions will result in frustration as managers attempt to assert control over that which is uncontrollable, a view that is shared by Shackley et al. (1996). Shackley et al. (1996) criticise complexity-based approaches that attempt to improve prediction and control of organisational behaviour as simply being methodological extensions of more traditional systems-based approaches.

In sum, no one can step outside his or her interaction with others, and there is no blueprint or design for the organisation as a whole (Stacey 2001). Understanding human action within organisations requires being a participant within that organisation, in that there can be no “context-free prescriptions” (Stacey et al. 2000, p.193).

6.3.9 Converging as Organising

6.3.9.1 Conversation as the Currency of Change

Given the challenge to prediction and organisational control presented by the complexity perspective, Burnes (2005) contests its usefulness, arguing that if organisations are to be understood as …dynamic non-linear systems capable of continuous transformation through self-organization, advocates of this approach will need to show either that it is more than just a metaphorical device, or that even as such it is able to resolve the problems of managing and changing organizations more effectively than other approaches that are on offer. (p.87)

Stacey (2003), however, cautions against viewing self-organisation as a new way of ordering an organisation or a new form of organisational behaviour to be strived for:

This seems to assume that self-organisation is some new form of behaviour rather than a different way of understanding how people have always behaved. The question is whether such self-organizing behaviour produces patterns that block or enable change. (p.278)

Stacey (2001) argues that instead of trying to manage and control the whole system, the emphasis should be on paying attention to one’s own local participation, and on patterns of interaction. From a methodological perspective, this means that organisational managers and researchers should adopt the role of participative inquirers (Stacey 2001). Senge (1990, p.69) sees people in organisations as having the capacity to shift from being “helpless reactors” to “active participants” in shaping their reality and the future. Senge places a strong emphasis on the role of conversation, or dialogue, as it is conceived by the physicist David Bohm (1991), where a group ‘becomes open to the flow of a larger intelligence’, and thought is approached largely as collective phenomenon (Smith 2001b).

However, conversation can foster persistence as well as change. Dialogue refers to the creative exploration of complex issues through active listening and the suspension of personal views and judgement (Bohm 1994; Bohm et al. 1991). As such, it has potential to foster conditions for insight and second order transformational change when dealing with complex problems (Senge et al. 2004).
Discussion, on the other hand, refers to the search for best arguments through the presentation and defence of different views, with the participant focused on ‘winning’ (Jashapara 2004). As such, it can be seen as an extension of Shotter’s (1994) rhetorical-responsive communication which aims to persuade. Consequently, attempting to problem-solve via discussion often reinforces existing power differentials and patterns of behaviour (i.e. first order change), as members work to defend and entrench their positions (as per Argyris & Schön 1996). Discussion is also often the mode of analytic conversations, whereby issues are rigorously dissected. As detailed earlier in Section 6.2.10, focusing on the parts of the problem tends to reinforce higher order patterns of behaviour that created the problem to begin with (Watzlawick et al. 2011). In essence, discussion and rhetoric are about trying to dominate the discourse in order to control how the external world is presented and understood. Dialogue, however, is about looking forward, imagining and co-creating a future together. Table 6.2 summarises Jashapara’s (2004) comparison of these two modes of discourse.

Table 6.2. Characteristics of dialogue versus discussion (Jashapara 2004).

<table>
<thead>
<tr>
<th>Dialogue</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose:</strong> to go beyond one’s understanding and become an observer of one’s own thinking</td>
<td><strong>Purpose:</strong> to find the best view and arguments to support the decision that needs to be made</td>
</tr>
<tr>
<td><strong>Requires:</strong> letting go of power differentials, treating each other equally; exploring assumptions behind closely held views</td>
<td><strong>Requires:</strong> presentation and defence of arguments, (note however that power, rhetoric and emotion, rather than logic or good arguments, can win)</td>
</tr>
<tr>
<td><strong>Useful for:</strong> divergent thinking, trying achieve a richer understanding of the issues rather than fostering agreement</td>
<td><strong>Useful for:</strong> convergent thinking, fostering agreement, decision-making</td>
</tr>
</tbody>
</table>

Stacey (1996b) suggests that dialogue will only change an organisation’s dominant pattern of behaviour if its effects on people’s actions are somehow amplified. If amplification does begin to occur, a period of discussion and power manoeuvring inside the organisation’s shadow system will follow. The more stable the organisation, the stronger its internal ‘organisational antibodies’, those members who attempt to block change and protect the status quo (see Brown & Duguid 2000; Stacey 1996a), and who are often the most powerful constituents of the organisation’s legitimate system. The less stable (i.e. closer to the edge of chaos) the organisation is, as is the case during a crisis, the less likely it is that the ‘antibodies’ will succeed in damping amplification of novel change (Stacey 1996a). The persistence of novel patterns of organisational behaviour also depends on the cooperative and competitive activities of the other organisations with which it interacts. Novelty can also be potentially amplified across an industry if organisations engage each other in creative processes (Stacey 1996b). Thus, creativity and innovation are “nested processes stretching from individual minds, through small groups and large organisations, to national and international industries, economies, and societies—and back down to again to individual minds” (Stacey 1996b, p.186).

Shaw (2002) suggests that managers need to accept that our interactions are always evolving in unpredictable, uncontrollable ways in the long term—despite attempts at sophisticated planning—and recognise the constant and recurring potential for change as we interact. Because of this, it is not possible for one individual or group thereof to dictate what behaviour patterns will emerge as a result of dialogue, or any other attempted intervention. However, an organisation’s behaviour will become more plastic and responsive to change as the number and complexity of interactions it and its members enter into increase. As such, Stacey and his colleagues argue that rich, diverse and unconstrained conversation between people is the currency of change in human systems. By increasing conversation between its members and outside groups, the system’s ability to respond and adapt to change is likewise increased87 (Shaw 2002; Stacey 2001), and the domain of possible interactions the organisation can potentially enter into are expanded (as per Maturana & Varela

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87 However, too much conversation, connection and diversity can also destabilise an organisation so much that it tips over the edge into chaos (Stacey 2001).
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Shaw (2002) states that our organising patterns change as we change our patterns of accounting to one another through conversation. Because conversation is integrated into people’s day-to-day interactions, it directly shapes their behaviour in the here and now, and thus the reality they are co-creating. Hence, conversation has greater influence on a system’s patterns of interaction than do abstract discussions carried out in isolation of ordinary practice and requiring formal pathways of planning and implementation (Shaw 2002). This phenomenon is apparent in Popper and Lipshitz’s (1998) observations that learning which is tightly integrated or indistinguishable from job performance is more effective than that which is abstracted from practice. This is likewise consistent with the communities-of-practice view (e.g. Brown & Duguid 1991). Thus, as outlined earlier in Section 6.2.8, people bring forth a world through their ongoing conversation and their social interactions.

6.3.9.2 Written vs. Verbal Dialogue

So what then is the role of the written word? Stacy (2005) claims that writing and printing technologies led to emergence of new social phenomena, such as bureaucracies, regulations, management by objective, and wide spread reliance on so-called tools of communication, such as reports, plans, databases, etc. According to Donaldson (2005), writing is not just a means of recording information and articulating and offering our thoughts to the reader—it also forces us to reflect on and organise our own thinking. Thus, writing allows us to enter into a form of dialogue, both with ourselves and with the words of others we would otherwise never meet, for example those of Plato written 2000 years ago (Donaldson 2005). As such, writing proffers the possibility of a much wider audience for our thoughts and imaginings—in both space and time—than that offered by conversation.

Verbal dialogue, especially face-to-face, is characterised by a creative and uninterrupted flow of cyclical stimulus-response between the parties involved, one that has an immediate effect on their patterns of interaction. Written dialogue, on the other hand, involves long delays between the time of writing and time of reading, and is usually a unidirectional exchange—the writer may influence the thinking and behaviours of the reader through his or her words, but the reader’s thoughts and reactions are not reflected back to the writer. As such, written communication and other unidirectional media, such as TV and radio, lack the creative flow of face-to-face dialogue, and the immediacy of physical response.

Donaldson (2005) suggests that modern reliance on the written word has cultivated generalised forms of thinking, whereby concepts (e.g. strategy, culture) are decontextualized from human interaction. She cites Ong, who states: “Writing fosters abstractions that disengage knowledge from the arena where human beings struggle with one another” (in Donaldson 2005, p.171). In addition, Donaldson states that reading and writing are typically solitary activities that distance us from others. She argues that by focusing on written communication, we become distanced from our immediate situations, and lose sight of the importance of our working relationships. As a result, we privilege planning over improvisation and engagement, abstract categorisation over direct experience, the written record over conversation, and communication tools over human relationships (Donaldson 2005). In so doing, we become alienated from each other, distancing ourselves from the immediacy of human interaction from which reality emerges, and the possibility of joint action and novel outcomes (see Bakhtin 1986).

6.3.9.3 Vision vs. Representation

“Don’t think. Thinking is the enemy of creativity. It’s self-conscious and anything self-conscious is lousy. You can’t try to do things. You simply must do things.”
—Ray Bradbury

Imagination and vision also play an important role in the relative impact of our communications on the emerging pattern of reality. For example, Mihevc, in his interview with CBC radio (Kennedy

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88 Excluding near-instantaneous forms of written dialogue, such as text messaging and email.
89 Attributed to the science fiction author Ray Bradbury by various sources.
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2012), states that politics is a struggle over people’s imaginations. He notes that politics has shifted away from trying to win over the public with detailed policy documents to focusing on vision instead. He argues that appealing to people’s reason doesn’t get you as far as appealing to their vision:

Vision is the most important thing in politics, as shown throughout human history. Leaders that have had an imaginative vision have been the most influential. Those that capture people’s aspirations unlock our imagination of the world that could be, apart from the world that is. (Kennedy 2012)

Thus, persuasion is better achieved by means of imagination or narrative, than by logic or analysis. This is consistent with the discussion in Section 6.2.6, which showed how imagination is a form of self-projection, which continuously transforms our reality by directing how we perceive and act into it. In sharing our imaginations during our conversations we expand the domain of our possible interactions and the future we collectively make. Together, we constantly create and improvise our existence (Kennedy 2012, citing others), in a dynamic tension of agreement and disagreement, cooperation and conflict (see Bakhtin 1986; Stacey et al. 2000). As such, our social reality can be understood as an emerging pattern of jostling, rhetoric-mediated imaginations.

This also explains why rhetorical-responsive speech is much more common in day-to-day interaction than is representational-referential communication. Rhetorical speech is the medium of jointly envisioning and creating reality in the here and now, whereas representational speech is a passive reflection of a system state put forward for logical analysis. When we consciously apply ourselves to analysing a task, we essentially turn off our imaginations and disengage from the active process of co-creating reality.

6.3.10 Knowledge Management

As touched on in Section 6.2.7, mainstream thinking also applies a cognitive view of knowledge, whereby knowledge is a product of learning, is stored in people’s minds as mental models representing an objective reality (Stacey 2001). Capra (1997) notes that in this computer-based model of cognition, knowledge is seen as context and value-free, and based on abstract data. From this perspective, knowledge is regarded as a ‘thing’ which one can be in possession of (Shotter 1994), be it tacit or explicit, know ‘how’ or know ‘what’, or regarded as a system which can be externally manipulated or controlled. Although those in the knowledge management field have long recognised that knowledge leading to action tends to be embodied unconsciously within the knowledge holder, i.e. as tacit knowledge, or know-how (Nonaka & Takeuchi 1995; Polanyi 1967), or within the relationships between people, i.e. relational knowledge (Park 1999)—the field has nonetheless largely focused on finding ways of stripping this knowledge from knowledge workers (see Waring 1991), so as to convert it into corporate asset (Snowden 2003).

From a complexity-based understanding, however, knowledge is learning—an active process of relating—not a product of learning which represents external reality. In Stacey’s (2001) view, knowledge cannot then be externally designed or manipulated, stored or managed. Explicit and tacit knowledge are facets of the same communicative process, and hence cannot be discussed separately, or converted from one to the other. Intellectual capital cannot be measured, the cleverness of the intellectual elite is irrelevant (it is their interactions that matter), and quality assurance in staff training and development is largely a charade that provokes more anxiety and frustration (Stacey 2001). Rather, learning occurs and knowledge arises in the ordinary everyday interaction between everyone in the organisation, and with those in other organisations (Stacey 2001). As posited by Maturana and Varela (1992), there is no knowledge without action and no action without knowledge.

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90 Stacey (2001) notes that corporate attempts to quickly expand organizational knowledge by merging with or acquiring another organization often have the effect of destroying what is bought. Relationships and everyday patterns of interaction, which are the essence of organizational knowledge, cannot be bought, and typically breakdown as staff are removed or moved-around.

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From a complexity perspective, the ‘knowledge’ of a system is equivalent to the domain and complexity of its interactions, which are what confer its behaviours with ‘plasticity’ (Section 6.2.7). Thus, the ‘knowledge’ of an organisation is not a measure of the information held within the heads of its members, or within artefacts such as databases, policies and procedures. Rather, ‘knowledge’ relates to the number and diversity of its connections between the organisation’s members and other systems. The ‘knowledge’ of a system can then be said to increase when new connections/relationships emerge between its agents and other systems. These added connections expand the scope of possible futures the organisation can co-create internally and with other systems. This contrasts with the Newtonian view of knowledge as an asset that helps the organisation to adapt to an external, pre-given environment.

According to Stacey (2001) many organisations could do more with less, and save time, money and frustration by abandoning ineffective knowledge management efforts that attempt to control or create knowledge as a ‘thing’. Instead, any attempts to ‘improve’ knowledge-creating capacity require attention to the quality and dynamics of human interaction in the present (Stacey 2001). This involves focusing attention on patterns of power relations and ideologies; who is talking and who is being silenced; who is excluded and who is included; how people manage their anxiety; and whether and how conversations are spontaneous and excited, or dull and repetitive (Stacey 2001). Shaw (2002) notes that this requires recognizing that conversing is organising, and that ordinary free-flowing conversation has the potential to generate transformational change.

6.3.11 Societal Change

“The gods presented her with a box into which each had put something harmful, and forbade her ever to open it…She was possessed of a lively curiosity. She had to know what was in the box. One day she lifted the lid and out flew plagues innumerable, sorrow and mischief for mankind. In terror, Pandora slapped the lid down, but it was too late.”

—Hesiod (as told by Hamilton, 1942)

The complexity perspective can also be extended to the societal level. Laszlo and Laszlo (2002b) apply General Evolutionary Theory, Ervin Laszlo’s (1996) synthesis of various complexity-based theories, to explain societal phenomena. They suggest that the tendency for open systems to become increasingly complex, as per non-linear thermodynamics, is demonstrated in how human social systems are progressively converging to higher and higher levels of organisational complexity as they become more interconnected. The last few thousand years have seen a rapid convergence of tribes and villages into ethnic communities, which in turn converged into states, then into nations, and now into large political and trade blocks (Laszlo & Laszlo 2002b). Each new level of organisational order emerges out of a period of instability, at which point a societal ‘bifurcation’, or transition, takes place. These transitions may be smooth, chaotic or catastrophic. During these times, “the reins of power change hands, systems of law and order are overthrown, and new movements and ideas surface and gain momentum” (Laszlo & Laszlo 2002b). These events may stabilise into a ‘new order’, in which the convergent subsystems (e.g. villages, or states) are unified into a new higher order pattern of behaviour; however, they may also cause a collapse into disaggregated individually stable subsystems (Laszlo & Laszlo 2002b).

Davidow (2011) suggests that the Internet has resulted in an over-connected global society, which is becoming increasingly destabilised from the amplifying feedback loops that are emerging as a result. He attributes over-connection to global economic instability and stock market volatility. Similarly, Stark (2006) suggests that the global political system is being driven into a chaotic phase by increasing interconnectivity within and between societies. He suggests a bifurcation point is looming, whereby a new unifying system of global governance will emerge, or catastrophic socio-ecological collapse will occur.

This perhaps explains the feeling many of us share, that our worlds are becomingly overwhelmingly complicated. As society becomes more connected, higher order organisational patterns begin to emerge ‘above us’, and in turn exert more and more downward governing pressure onto our own localised behaviours. Hence, for some of us, our feelings of being out of control mount, as these
larger, higher order patterns entrain our individual local patterns for their own self-reinforcement. For others, the sense is one of excitement, of being part of something bigger and newer, the 21st century zeitgeist.

6.4 Summary & Conclusions

Traditional information processing views of cognition, by using terms such as ‘theory’ or ‘mental model’ to describe coherent patterns of behaviour—thereby assuming that the brain actually has somehow stored within it a ‘map’ representing reality—are committing an error in logical typing, as per the Theory of Logical Types. The linguistic symbol used to represent, or distinguish, a pattern of relating (i.e. mental model) is assumed to be a real ‘thing’. Hence, the map is being confused with territory—a process or pattern is being confused with a ‘thing’, wherein the two are of clearly distinct logical types.

The Santiago view, by contrast, regards cognition as an active process of relating, which is a direct extension of a complexity-based ontology. Consciousness, behaviour, communication, and language are all just extensions of cognition—higher order patterns of interaction that emerge from iterative couplings between living systems. With each new cognitive order (i.e. consciousness, language), the complexity of interactions into which the organism enters increases dramatically, nudging it closer to the edge of chaos and increasing its environmental responsiveness and capacity for novel, qualitatively different behaviour (i.e. a mental map of reality), an error in logical typing is avoided. As such, the Santiago view is able to resolve the paradoxes created by the information processing view of cognition, such as the escalation of error that can occur when analytical thinking is applied to complex problems.

Rather than seeing cognition as a means to navigate, or adapt to, an external pre-given reality, in the Santiago view, individuals are seen to mutually construct themselves and the world of others via their cognitive interactions with one another. As such, mind can be seen as contributing to the construction of reality, particularly if one takes Maturana and Varela’s view that no ‘things’—living or non-living—exist independently of cognition. Interestingly, this perspective resonates with Alexander’s forgotten theory of emergentism, a hierarchal process whereby spacetime—a vast unity of motion—leads to matter, matter leads to mind, and mind leads to deity (Thomas 2012, see Appendix 1, Section A1.5.4).

From the perspective of the Newtonian paradigm, organisations are regarded as ‘things’, which can be manipulated and controlled by those who stand outside of them. Organisational behaviour is dictated by the organisation’s theory-in-use, which is a shared mental model of reality held by its members. Organisations are said to learn when their members learn and act on their behalf. Organisational knowledge is regarded as a ‘thing’ that can be stripped from workers and commoditised into an organizational asset. However, when viewed from a complexity-based ontology, we can see that an organisation is not a thing; rather it is a stable pattern of interaction, an extension of cognition as understood from the Santiago perspective. This pattern emerges from the interactions of its members and is shaped by its couplings with other systems.

Organisations cannot be manipulated or controlled by any one individual or group of individuals, and their behaviours are often far out of alignment with their formal purposes. Change happens spontaneously in organisations, and because it cannot be controlled it may not be desirable. Organisations become more responsive and prone to transformational change when the number and diversity of connections between their members and other systems increases. They are continuously learning by virtue of the continuous interactions with other systems. Organisational knowledge is not a ‘thing’ that can be stripped from its members; rather it pertains to the connectedness of the organisation and the domain and complexity of interactions it can potentially enter into. Conversation is the currency of change in organisations, and when the nature of

 Which themselves are actually coherent patterns of relating among multiple entities.
organisational members’ thinking and conversation is creative and non-judgemental, rather than analytic and/or defensive, the potential for transformational change in the system increases.

From the syntheses above, we can see how replacing the assumptions of the mainstream Newtonian paradigm with those of a complexity-based paradigm has profound implications for how we understand learning, knowledge, organisations and other social phenomena (see Table 6.3 for a summary comparison). For example, viewing organisations as *things*, rather than creative *processes*, is yet another instance of Newtonian ‘flattening’, an error of logical typing whereby the emergent dimension of unified spacetime is disregarded[92]. Such errors generate paradox, such as the organisational learning paradox, whereby organisations appear to be both processes, by virtue of their behaviours, and things, by virtue of their containment of knowledge. Scholars have tried to resolve such paradoxes by ascribing complicated cognitive mechanisms involving mental models (i.e. theories-in-use), thereby keeping the Newtonian paradigm intact, with its assumption of an external objective reality. As such, mental models are the equivalent of epicycles in Ptolemy’s geocentric solar system. If we replace the Newtonian paradigm with a complexity-based paradigm, and organisations are thus understood as emergent *processes*, or patterns of interaction (rather than things), the organisational learning paradox is resolved. Hence, the notion of mental models can be discarded, just as Copernicus was able to discard epicycles in his heliocentric solar system.

The phenomena of cognition, learning, knowledge and organising are key elements of knowledge transfer and research uptake. The syntheses described in this chapter can serve as an alternative framework for understanding the nature and behaviour of socio-ecological systems and the intractable and wicked problems we encounter when we try to manage them using strategies such as knowledge transfer. In Chapter 7, I will discuss the implications of this complexity-based framework in relation to science, knowledge transfer and adaptive capacity, and in relation to the unanticipated findings of my Ningaloo action research study, as outlined in Chapter 4.

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[92] Regarding any phenomena as a ‘thing’ is the consequence of Newtonian ‘flattening’ of unified and emergent four-dimensional spacetime.
Table 6.3. A comparison of learning, knowledge and organising, as understood in the mainstream Newtonian paradigm versus the proposed complexity-based paradigm.

<table>
<thead>
<tr>
<th>MAINSTREAM NEWTONIAN PARADIGM</th>
<th>SOURCE</th>
<th>PROPOSED COMPLEXITY-BASED PARADIGM</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our brains store mental models that represent external reality. Remembering is an act of retrieving these stored models.</td>
<td>Materialism, cybernetics, cognitive psychology</td>
<td>Our brains do not possess storage systems or mental models. Remembering is part of <strong>prospection</strong>, an imaginary, constructive process that couples us with other systems and our shared history.</td>
<td>Neuroscience (Buckner &amp; Carroll), transcendental idealism (Kant), Autopoiesis (Maturana &amp; Varela),</td>
</tr>
<tr>
<td>Cognition is information processing — comparing our experiences with our stored mental models, and testing different options in our minds prior to taking action.</td>
<td>Materialism, cybernetics, cognitive psychology</td>
<td>Cognition is a continuous process of coupling between ourselves and other systems—all living systems are cognitive systems.</td>
<td>Panpsychism (Whitehead), Autopoiesis (Maturana &amp; Varela), dynamical systems view of cognition (Varela et al.),</td>
</tr>
<tr>
<td>Knowledge is created as we observe reality through our senses, then store it in our minds as a mental representation. We learn when we use new knowledge to adjust our mental models to be a more accurate representation of external reality.</td>
<td>Materialism, empiricism, positivism, cybernetics, cognitive psychology</td>
<td>Knowledge, or learning, is ‘successful cognition’, whereby an organism couples with other systems without interruption to its own circular pattern of organisations. Thus knowledge is not a ‘thing’.</td>
<td>Autopoiesis (Maturana &amp; Varela),</td>
</tr>
<tr>
<td>Our mental models of reality dictate our behaviour via information processing.</td>
<td>Cybernetics, cognitive psychology</td>
<td>Our behaviours are patterns of interaction/coupling that emerge through our shared history with other systems.</td>
<td>Autopoiesis (Maturana &amp; Varela), dynamical systems view of cognition (Varela et al.), social constructivism (Shotter, Bakhtin),</td>
</tr>
<tr>
<td>Cognition is the means by which we navigate and adapt to an external reality.</td>
<td>Materialism, cybernetics, cognitive psychology</td>
<td>Cognition is the means by which we mutually construct reality via our interactions with other systems.</td>
<td>Autopoiesis (Maturana &amp; Varela), social constructivism (Shotter, Bakhtin), process philosophy (Whitehead),</td>
</tr>
<tr>
<td>Communication and language involve transmitting information/messages for processing by the recipient.</td>
<td>Cybernetics, communication theory, cognitive psychology</td>
<td>Consciousness, behaviour, communication, and language are all just extensions of cognition—higher order patterns of interaction of that emerge from iterative couplings between living systems.</td>
<td>Autopoiesis (Maturana &amp; Varela), social constructivism (Shotter, Bakhtin),</td>
</tr>
<tr>
<td>By allowing us to exchange information, communication and language help us improve our mental models of external reality and thereby adapt to it.</td>
<td>Materialism, cybernetics, cognitive psychology</td>
<td>With each new cognitive order (i.e. consciousness, language), the complexity of interactions into which an organism enters increases dramatically, nudge it closer to the edge of chaos and increasing its responsiveness and creative capacity/plasticity</td>
<td>Autopoiesis (Maturana &amp; Varela), complexity theory (Kauffman),</td>
</tr>
<tr>
<td>Given sufficient and accurate information, analysis can solve all problems.</td>
<td>Materialism, reductionism, scientific realism, positivism</td>
<td>Insight is needed to solve complex problems because analysis cannot quantify across system boundaries. Analysis also impairs insight, and tends to worsen complex problems.</td>
<td>Neuroscience (Kounios et al.), single vs. double-loop learning (Argyris &amp; Schon), first vs. second order change (Watzlawick et al.), Theory of Logical types (Whitehead &amp; Russell, Bateson), Group Theory (Galois), chaos theory</td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>An organisation is a 'thing'.</td>
<td>Materialism, organisational learning, organisational management</td>
<td>An organisation is a higher order unifying (circular) pattern emerging from the interactions of its members and shaped by its couplings with other system</td>
<td>Autopoiesis (Maturana &amp; Varela), complex responsive processes (Stacey)</td>
</tr>
<tr>
<td>Organisational behaviour is dictated by the organisation's theory-in-use, which is a shared mental model of reality held by its members.</td>
<td>Organisational learning (Argyris &amp; Schon)</td>
<td>An organisation's behaviour is a governing pattern emerging from a multitude of interactions between its members and other systems; i.e. an organisation is its behaviour.</td>
<td>Autopoiesis (Maturana &amp; Varela), social constructivism (Shotter, Bakhtin), complex responsive processes (Stacey), complexity theory (Kauffman)</td>
</tr>
<tr>
<td>Organisations can be manipulated and controlled by those who stand outside of them, in order to achieve externally dictated goals (e.g. profit, competitiveness).</td>
<td>Organisational management, systems dynamics, organisational development</td>
<td>An organisation's only 'motive' is to maintain its identity—hence it resists changes that might affect its overall governing pattern. It cannot be manipulated or controlled by any one individual or group. Its behaviours are often far out of alignment with its formal purpose. Transformational change occurs spontaneously, often precipitated by crisis.</td>
<td>Autopoiesis (Maturana &amp; Varela), complex responsive processes (Stacey), complexity theory (Kauffman), organisational learning (Nystrom &amp; Starbuck)</td>
</tr>
<tr>
<td>Organisations learn when their members detect discrepancies between the organisation's theory-in-use and reality, then successfully correct the discrepancy on the organisation's behalf.</td>
<td>Organisational learning (Argyris &amp; Schon)</td>
<td>Organisations are continuously learning by virtue of their ongoing interactions with other systems.</td>
<td>Autopoiesis (Maturana &amp; Varela), complex responsive processes (Stacey), complexity theory (Kauffman)</td>
</tr>
<tr>
<td>Organisational knowledge is a 'thing' that can be stripped from workers and commoditised into an organisational asset. It is embedded into the organisation's policies and structures, and the mental models of its members.</td>
<td>Scientific management (Taylor), knowledge management, organisational learning (Argyris &amp; Schon)</td>
<td>Organisational knowledge is not a 'thing' that can be stripped from its members; rather it relates to the connectedness of the organisation and the domain and complexity of interactions it can potentially enter into.</td>
<td>Autopoiesis (Maturana &amp; Varela), complex responsive processes (Stacey), complexity theory (Kauffman)</td>
</tr>
<tr>
<td>Organisations improve their adaptive capacity by improving their knowledge about their environment.</td>
<td>Organisational learning, knowledge management, organisational</td>
<td>Organisations increase their creative capacity (the range of possible futures they can co-create with other entities) by</td>
<td>Autopoiesis (Maturana &amp; Varela), complex responsive processes (Stacey), complexity theory (Kauffman)</td>
</tr>
</tbody>
</table>
management  increasing the domain and complexity of interactions they enter into (via the number and diversity of their connections).

| Analytical discussion can solve organisational problems. | Reductionism, scientific realism, positivism | When the nature of organisational conversation is creative and non-judgemental (i.e. dialogue), rather than analytic and/or defensive (i.e. discussion), the potential for insight into complex problems and transformational change in the system increases. Analysis can worsen complex problems. | Single vs. double-loop learning (Argyris & Schon), suspension (Bohm), first vs. second order change (Watzlawick et al.), Theory of Logical types (Whitehead & Russell, Bateson), Group Theory (Galois), chaos theory |
Chapter 7

IMPLICATIONS FOR SCIENCE & ENVIRONMENTAL MANAGEMENT

“A picture held us captive. And we could not get outside it, for it lay in our language and language seemed to repeat it to us inexorably.”
—Wittgenstein (1953)

7.1 Introduction

As per Watzlawick’s principles of problem formulation, in order to re-evaluate the findings of my Ningaloo action research study (Chapter 4), I needed to firstly examine my assumptions, and then secondly revise my assumptions and open my mind to alternative ways of thinking. In Chapter 5, I surfaced the underlying of the Newtonian paradigm that currently dominates Western thinking, then synthesised an alternative complexity-based paradigm. In Chapter 6, I then compared how cognition, learning, knowledge and organising have been understood within the Newtonian paradigm, versus how they can be alternately understood from the perspective of a complexity-based paradigm. The third step in Watzlawick’s problem principles formulation requires that I reframe the problem in accordance with the revised set of assumptions—i.e. within a new paradigm. This final chapter takes that third step.

The term paradigm brings us to the work of Thomas Kuhn. In 1962 Thomas Kuhn published his influential book The Structure of Scientific Revolutions. Kuhn started his career as a physicist, but shifted his focus to the history and philosophy of science in the 1950s (Bird 2011). In his book, Kuhn traces the history of science and concludes that it progresses through periods of slow stable growth, punctuated by revolutionary paradigm shifts, marked by crisis before one prevailing theory is discarded and replaced by another (Chalmers 2002). He rejects the idea that science precedes in a gradual progression that incrementally reveals the true nature of reality. Rather, his historical view suggests that as a new, disorganised science becomes more and more organised, it eventually structures into a ‘normal science’ consisting of a single paradigm. A scientific paradigm comprises the beliefs, general theoretical assumptions, laws and techniques adopted by its particular scientific community (e.g. the Newtonian paradigm) (Chalmers 2002). However, as discussed earlier, Godel’s Incompleteness Theorem demonstrates that there are problems which cannot be solved within the paradigm they are situated in, and this is particularly so in the case of intractable, or ‘wicked’ problems (see Conklin et al. 2007; Watzlawick et al. 2011).

In normal science, scientific effort is focused on validating and reinforcing the existing paradigm, which Kuhn describes as puzzle-solving governed by the rules of the paradigm (Chalmers 2002). Normal scientists therefore assume “that a paradigm provides the means for the solution of the puzzles posed within it”, and are therefore uncritical of it (Chalmers 2002, p.110). As such, observations or theories that fail to fit the dominant paradigm are often discredited or dismissed as anomalies by the normal scientific community. However, as challenging evidence ‘piles up’ and can no longer be ignored, a point of crisis is reached. This is resolved when a new paradigm develops, to which scientists increasingly defect, until the old paradigm is finally abandoned in favour of the new (Chalmers 2002). As such, Kuhn challenged long-held empirical and positivist assumptions of an objective reality which is methodically revealed through the workings of science. His work shows that even scientific reality is largely a social construction, susceptible to social and cultural influences.

The discussions outlined in Chapters 5 show how the limits of reductionist science are being made apparent by quantum and complexity theory. In particular, Godel’s Incompleteness Theorem, quantum uncertainty and the unpredictability of chaotic systems have demonstrated the fundamental limitations of scientific knowledge. The premise behind Godel’s theorem shows that no set of axioms or premises, regardless of how detailed, can fully describe or explain a system93.

93 Ibid. 5, p.14.
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Thus, the assumption that uncovering more rules and premises will lead to a greater ability to describe the world is subject to diminishing returns\(^{94}\)—i.e. explanation has an upper limit (James 2002). James (2002) states that efforts to explain a situation “through development and testing of hypotheses derived from a theory will converge towards some maximum point”—an upper limit of description, prediction and explanation.

Heylighen et al. (2007) suggest that since we cannot completely describe complex systems, as per complexity theory, we cannot devise unchanging and non-provisional sets of rules to control their behaviour. Richardson (2005) likewise states that the emerging complexity sciences are forcing us to revisit the nature of scientific knowledge and the limits of scientific methods. He notes that while many of the criticisms of science have been made by non-scientists, complexity science is now leading a critique of science from within its own paradigm, ironically enabled by dogmatically applied reductionist science (Richardson 2005, 2008).

However, just as Kuhn (1962) predicts, many complexity researchers (i.e. ‘normal’ scientists) are still ‘implicitly clinging’ to the Newtonian paradigm, trying to find mathematical laws of complexity that will allow the restoration of some form order and determinism to the unpredictable, non-linear world they are trying to understand (Heylighen et al. 2007; Tsoukas & Hatch 2001). This is seen in the work of Holland (1987) which decomposes the workings of complex adaptive systems as if they were information-processing machines, with the aim of improving prediction and control (see Appendix 3, Section A3.7.4). Researchers such as Holland appear to have gained ‘representational’ knowledge of complex systems, but without having embodied this knowledge tacitly. Thus their assumptions about the fundamental nature of reality remain intact, and the Newtonian paradigm unchallenged. Complexity thinking without a shift in ontology simply becomes an extension of systems thinking, a more sophisticated means of trying to predict and control system behaviour.

Heylighen et al. (2007) suggest that this is because complexity researchers come from a relatively recent scientific background and have not yet reflected about the philosophical foundations of their approaches. This is a legacy of the pre-WWII divorce logical positivists precipitated between science and philosophy (see Appendix 1, Section A1.5.8). This same divorce led to the abandonment of ecology’s idealist and organicist roots after Tansley declared war on it in 1935 (Bellamy Foster & Clark 2008), replacing early ecology’s focus on pattern, holism and organising relations with his materialist approach and a trophic dynamics focus (see Appendix 1, Sections A1.5.1 & 5.2). Scientists of today are seldom educated in philosophy, and typically no longer reflect on the metaphysical implications and assumptions of their work\(^{95}\) (Rovelli 2012).

However science does not just seek to manipulate nature, it also seeks to understand to “dig deeper into questions that have been asked generation after generation” (Prigogine & Stengers 1984, p.291). The works of other complexity researchers, such as Kauffman and Prigogine, show fundamental ontological and epistemological shifts that challenge the reductionist and determinist assumptions of the Newtonian paradigm (refer to Appendix 3 for details). Complexity thinking in their cases has resulted in a new understanding of the nature of reality, that of an immaterial, indeterminate, and interconnected universe being perpetually created, as outlined in Chapter 5. This is a radical departure from the Newtonian view of the universe as a shifting atomic configuration of matter and energy.

In this chapter, I will outline the limits of reductionist science as understood through this synthesised complexity-based paradigm. I then compare the role of science in the Newtonian versus the proposed complexity-based paradigm, and rethink the concept of knowledge transfer accordingly, drawing also on discussions from Chapter 6. From here I discuss the implications of this shift in thinking in terms of the paradoxes posed by the notions of knowledge transfer and adaptive capacity in environmental management, and the wicked problems they inadvertently

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\(^{94}\) Description increases as a function of axioms, but at a diminishing rate of increase (James 2002).

\(^{95}\) By example, Francis Bacon recognised that the mind is a ‘crooked mirror’, and the importance of purging one’s mind of its ‘idols’ (rubbing out its pre-existing assumptions and interpretations) prior to attempting to acquire new knowledge (Klein 2012).
generate. I then reframe the Ningaloo action research study (Chapter 4) in light of this discussion, and present a reconceptualization of knowledge transfer from a complexity perspective. This is followed by the study conclusion.

7.2 Limits of Reductionist Science

“Unfortunately, non-chaotic systems are very nearly as scarce as hen’s teeth, despite the fact that our physical understanding of nature is largely based on their study….Algorithmic complexity theory and non-linear dynamics together establish the fact that determinism reigns only over a quite finite domain; outside this small haven of order lies a largely uncharted, vast wasteland of chaos.”

—Ford (1983)

7.2.1 Stability

Richardson (2005) argues against the Newtonian possibility of complete and certain and knowledge, stating that “Contrary to popular belief, science is not capable of considering all phenomena. In fact, it is quite inflexible in its requirements” (p.617). In the Newtonian paradigm entities or phenomena must be stable to be assumed to be ‘real’. In being stable, their ‘pattern’ can be distinguished from the ‘background’ (Richardson 2005), i.e. the larger web of interactions of which they are part. Indeed, the main requirement of scientific explanation is that the phenomena of interest must be very stable—sufficiently so that they can be repeatedly measured and examined, and their behaviours predicted via the principles of cause-and-effect (Richardson 2005).

According to Richardson (2005) the scientific method yields excellent results when applied to such situations, especially when dealing with mechanical ‘things’ that are constructed of parts that stay the same. However, when dealing with complex self-organising systems, which are constantly evolving and their boundaries continuously changing and emerging—stability and predictability begin to break down, particularly at the scale of social systems (Richardson 2005). Here the limits of the scientific method become evident. Snowden (2003, citing others therein) states that this is because cause-and-effect are intimately intertwined and inseparable in complex adaptive systems. He illustrates the vital difference in dealing with a complex versus a complicated system as follows:

When a rumour of reorganisation surfaces: the complex human system starts to mutate and change in unknowable ways; new patterns form in anticipation of the event. On the other hand, if you walk up to an aircraft with a box of tools in your hand, nothing changes. (Snowden 2003, p.25)

It should be reiterated, however, that from the perspective of the complexity-based ontology outlined in Chapter 5, stability is scale and observer dependent. Systems become more or less chaotic depending on the spatial and temporal scales at which they are observed. A phenomenon that appears unstable at one scale may be seen as ordered and stable at another. Thus, the applicability of the scientific method is likewise scale dependent—it is not universal. For example, reductionist science provides good explanatory capability at the cellular level (cells also being complex self-organising systems), but its predictive powers become more limited as you move up in scale and dimensions of complexity, from cell to organism, to ecosystem, then to biosphere.

To apply reductionist science to complex self-organising systems that are not highly stable and coherent, we essentially have to fake stability (Richardson 2005), as did engineers of the last century with their linear approximations (see Capra 1997). And in so doing, we shore up our beliefs and perceptions that these dynamic, unpredictable systems can be tamed and controlled, if only we gather sufficient information about them. Thus the Newtonian scientific paradigm is perpetuated, and evidence pointing to alternate ways of understanding the world is denied or rejected, as predicted by Kuhn (1962).

7.2.2 Emergence

“When scholars study a thing, they strive to kill it first, if it’s alive; then they have the parts and they’ve lost the whole, for the link that’s missing was the living soul.”

—Goethe, Faust (1834)
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The other limitation of the scientific method is in dealing with emergent phenomena. Mainstream reductionist science concerns itself with parts and quantities. It presumes that all ‘real’ phenomena and the relationships between them can be somehow quantified, and their behaviours predicted as per the laws of cause-and-effect. However, while quantification lends itself well to describing and predicting phenomena operating within a particular level or order of complexity (i.e. the parts of a whole), it cannot be used to explain emergence in self-organising systems, which involves a qualitative jump to a higher order of complexity (i.e. system level or logical level). The premises, rules and descriptors that apply to one level of order cannot be applied to a higher level of emergent order—a new framework is required (i.e. the whole is greater than the sum of its parts), as per Godel's Incompleteness Theorem, the Theory of Logical Types (Appendix 2), and as detailed in Chapter 5, Section 5.3.7.

While reductionist science can deploy different sets of tools to effectively quantify and analyse phenomena (provided they are sufficiently stable, relative to the observer) at different logical levels, it cannot explain the transition, or relations between the logical levels. This is because it cannot quantify across levels. The frameworks of rules and premises governing each level are quantitatively different, and so too must be the metrics that are deployed. Here is a simple example: an object's change in position can be quantified using multiplication to calculate velocity, but quantifying a change in the change of its position (meta-change resulting in a jump to a higher logical type) requires using differential calculus to calculate acceleration. Trying to measure velocity with calculus or acceleration with multiplication clearly leads to nonsense. As we can see, attempting to apply logical, cause-and-effect analysis across these levels amounts to comparing apples to oranges, and in so doing generates paradox.

Bateson (2000) invites his readers to this “psychological experience” by which he demonstrates the “frailty of the human computer” (p.463), and how confusion multiplies when attempting to define the difference between differences between logical levels (i.e. meta-difference), whilst holding our Newtonian ‘maps’ depicting a quantified territory:

> First note that differences in texture are different (a) from differences in colour. Now note that differences in size are different (b) from differences in shape. Similarly ratios are different (c) from subtractive differences. Now let me invite you, as disciples of Korzybski, to define the differences between “different (a),” “different (b),” and “different (c)” in the above paragraph. The computer in the human head boggles at the task.” (p.463-64)

Reductionist methods have no means of bridging logical/system levels, because levels are separated by qualitative not quantitative divides. This relates to neuroscience and psychological research, detailed in Chapter 6, Section 6.2.10, indicating that insight into solving complex problems occurs spontaneously, in the absence of analytic thinking (e.g. Kounios et al. 2006; Watzlawick et al. 2011). Bridging qualitative divides involves activating the pattern recognition mode of the brain’s right hemisphere (McGilchrist 2012), from which our intuition, creativity, artistry and aesthetic sensitivities arise (Bateson 2000). Notably, these are modes of thought not conventionally valued or applied within the mainstream scientific paradigm. Also notable are Einstein's repeated exhortations that he learned more from Fyodor Dostoyevsky than he did from any physicist (Prigogine 1997).

Thus, once again, it is important to recognize that, while very useful when dealing with stable phenomena, the scientific method (as applied by ‘normal’ science\(^{96}\)) is not universally applicable. As we have just seen, it cannot be used for describing or explaining emergence or the transitions between higher and lower order levels of complexity (logical levels). Attempting to apply system metrics (and conjoined rules and premises) across system levels in order to quantify them is again a

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\(^{96}\) In contrast to post-normal science, as outlined by Funtowicz & Ravetz (1993), which applies dialogue with 'extended peer communities', rather than just traditional problem-solving, as a means of quality assuring science when uncertainty and/or decision are stakes are high.
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denial of complexity\textsuperscript{97}. Not only does this reinforce the Newtonian paradigm of a predictable, deterministic universe, it also generates undesirable paradoxical situations such as vicious circles, games-without-end, and deadlocks—elements of what we refer to in environmental management as \textit{wicked problems}.

7.2.3 Prediction

As discussed in Chapter 5, Section 5.3.15, order and chaos are spatially and temporally laminated in the dynamic, nested patterns of interaction (i.e. systems) that comprise reality. The chaotic laminations are transition zones, dynamic, observer-dependent boundaries that signal a qualitative change in pattern (a jump to a different system level), and with it a new set of governing rules and premises. These zones embed the larger system whole with uncertainty, because no singular set of assumptions, rules and metrics and can cross them, thereby ruling out cause-and-effect prediction\textsuperscript{98} across system boundaries, and making for irreducible uncertainty. This serves to intrinsically limit the explanatory power of any given quantitative method\textsuperscript{99} of description.

7.2.4 Dissolving Paradox

Thus the complexity sciences can help us recognize that reductionist methods cannot be universally applied, and that we cannot privilege the quantitative over the qualitative. To better understand the seemingly paradoxical ‘Janus-face’ of reality, quantitative descriptions of its stable aspects must be laminated with qualitative descriptions its chaotic aspects. When we do so, reality’s ‘Janus-face’ is revealed as a mask. As it begins to dissolve, so do its paradoxes, leaving us with a vision of the whole.

Unfortunately, however, by nature and by paradigm, humans have difficulty discerning the boundaries where governing patterns change, and are therefore prone to committing errors in logical typing. Consequently, we frequently and inadvertently create paradoxical situations from which we have difficulty escaping, despite our best efforts. In the following pages, I will discuss a number of paradoxical situations pertaining to knowledge transfer and adaptive capacity.

7.3 Re-thinking Knowledge Transfer

\begin{quote}
"The way out is through the door. Why is it that no one will use this exit?"
– Confucius
\end{quote}

7.3.1 Role of science in the Newtonian Paradigm

The role of science in the Newtonian paradigm is to improve the ‘map’ in the observers’ minds, so it is a more accurate reflection of reality (Heylighen \textit{et al.} 2007). This achieved through empirical and objective observation of the external world, using the scientific method to collect and analyse information about it, thereby further completing the ‘picture’ of external reality (Heylighen \textit{et al.} 2007). Ultimately this will lead to a perfect picture, or map, of reality, enabling us to make accurate predictions of all phenomena (Heylighen \textit{et al.} 2007). According to Heylighen \textit{et al.} (2007), this view requires making precise distinctions between the different components, properties and states of the systems under observation, i.e. reductionism, and assumes that these distinctions will be the same for all observers—i.e. they will be objective. Thus mainstream science is not a creative enterprise, it is one of uncovering (Heylighen \textit{et al.} 2007). On this basis, positivist and realist philosophies of science see science as progressively revealing the ‘true’ nature of reality. Table 7.1 provides a summary comparison of the role and application of science from Newtonian versus complexity-based perspectives.

\textsuperscript{97} When insisting that reductionist methods can and should be applied to all ‘real’ phenomena, scientists are signalling their adherence to the mainstream scientific paradigm.

\textsuperscript{98} Noting however that \textit{probabilistic} prediction then applies, and that chaos and therefore predictability are dependent on the scale at which a system is observed.

\textsuperscript{99} While also recognising that qualitative methods also have limitations.
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Table 7.1. A comparison of the role and application of science from the perspective of the mainstream Newtonian paradigm versus the proposed complexity-based paradigm.

<table>
<thead>
<tr>
<th>MAINSTREAM NEWTONIAN PARADIGM</th>
<th>SOURCE</th>
<th>PROPOSED COMPLEXITY-BASED PARADIGM</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reductionist methods can be universally applied to all phenomena</td>
<td>Determinism, reductionism, positivism</td>
<td>Reductionist methods are ineffective at describing/predicting unstable or emergent phenomena.</td>
<td>Chaos theory, complexity theory</td>
</tr>
<tr>
<td>All phenomena can be quantified and accurately predicted, given sufficient information</td>
<td>Determinism, reductionism, positivism</td>
<td>Quantitative methods cannot be applied across emergent/chaotic boundaries, ruling out cause-and-effect prediction. Qualitative methods are required.</td>
<td>Chaos theory, complexity theory</td>
</tr>
<tr>
<td>Given complete information humans make rational decisions</td>
<td>Rationale Choice theory, Game theory, Druckerism</td>
<td>Humans make decisions based on constraints, opportunities and power relations imposed by relationships</td>
<td>Autopoiesis (Maturana &amp; Varela), complex responsive processes (Stacey), social constructivism (Bakhtin), postmodernism (Foucault)</td>
</tr>
<tr>
<td>Science progresses by gradually revealing the true nature of reality</td>
<td>Positivism, Scientific Realism</td>
<td>Science normally works to validate existing paradigms until crisis causes revolutionary shifts to new ones</td>
<td>Paradigmatic revolutions (Kuhn)</td>
</tr>
</tbody>
</table>

Heylighen et al. (2007) argue that Newtonian thinking that favours determinism over free will is what ultimately led to the dominance of ‘rationality’ in social and economic modelling:

Assuming perfect information about the utility of possible options, the actions of mind then become as determined or predictable as the movements of matter. This allowed social scientists to describe human agency with most of the Newtonian principles intact. (p.121)

According to the authors, this has led to a widespread assumption that, given complete information, people will make ‘rational choices’, meaning people will predictably choose options with the greatest ‘utility’, which represents some objective value or ‘goodness’. They argue that this has led to an assumption that increases in scientific knowledge typically lead to increases in global utility or well-being, i.e. linear progress. This belief in the incremental uncovering of the ‘true’ nature of reality by science, combined with notions of rational choice and linear progress, defines the Western project of modernity (Heylighen et al. 2007), and how we believe the world works. As a consequence, our mainstream view of the role science in society is fundamentally premised on a string of materialist assumptions:

1. Reality exists outside of and independently to us (materialist ontology)
2. Reality is knowable (materialist epistemology)
3. Knowledge is created as we observe reality through our senses (empiricism)
4. We use this knowledge to create mental models of reality (cognitivism)
5. Our knowledge and mental models are imperfect and incomplete (scientific realism)
6. Science works to progressively uncover the true nature of an objective reality (scientific realism/positivism).
7. Humans process information like computers, and make rational decisions based on their knowledge and mental models of reality (rational choice theory/cognitivism).

Refer to Appendix 4, Section A4.2 for an overview of rational choice theory in economics.
8. When given complete information about the utility of different options, humans will always choose the ‘best’ one (rational choice theory/determinism).

9. The more information we have about the true nature of reality, the better choices we’ll make, and the greater our wellbeing (global utility/linear progression).

10. Therefore scientific knowledge leads to perfect knowledge/models of an objective reality, which leads to perfect choices, which leads to an ideal state of well-being.

11. Therefore increases in scientific knowledge = increase in our well-being.

Thus, in the Newtonian paradigm, complete, objective and certain knowledge of past and future reality is possible (Heylighen et al. 2007). Uncovering this reality then becomes the mission of science, one which will ultimately increase our global well-being. From this string of assumptions emerges the rationale for knowledge transfer.

7.3.2 Rethinking Knowledge Transfer

As outlined in Chapter 3, whereas knowledge management is concerned with managing knowledge as an organisational asset, knowledge transfer is concerned with transferring knowledge from one organisation to another, typically from a research body to a management agency, or from researchers to practitioners. The objective of knowledge transfer is to see scientific information applied in practice and decision-making; knowledge transfer without adoption is considered a failure (Roux et al. 2006).

Like knowledge management, knowledge transfer, as its name suggests, is premised on Newtonian assumptions of knowledge as a ‘thing’, and the computer or information processing view of cognition and learning (Chapter 6, Section 6.3.10). It is also premised on the assumptions of rational choice theory, whereby people are expected to make rational decisions once in possession of complete information. This is exemplified by McNie (2007), who argues that the main goal of knowledge transfer is to create useful information for decision-makers; and Roux et al. (2006), who state that its objective is the unobstructed flow of knowledge between managers and researchers (Chapter 3). In both cases, the authors regard knowledge as a ‘thing’, with the goal being exchange of information that will lead to better decision-making. Indeed, much of the knowledge transfer literature is focused on ways to make information more palatable and relevant to managers and policy makers, such as by improving how its packaged and increasing its salience, credibility and legitimacy (McNie 2007, citing others therein).

However, as the conceptual framework outlined in Chapter 3 demonstrates, there is also an increasing recognition in the literature that research uptake is improved if knowledge transfer is accompanied by some form of relationship building and participation. For example, McNie (2007) refers to the importance of social capital in ensuring the legitimacy of scientific information, and recommends strengthening links between scientists and policy-makers through participatory processes, adaptive management, and boundary organisations/spanners. Roux et al. (2006) emphasise the importance of the ‘tacit’ dimension of knowledge and the need to create common spaces where managers and scientists can meet and share knowledge. They likewise propose that ‘unified learning systems’ are needed, whereby scientists and decision-makers work together to create new knowledge, as do numerous other authors (e.g. Born et al. 2009; Cash & Moser 2000; Hunt & Shackley 1999; Kainer et al. 2009; Lemos & Morehouse 2005; Shackleton et al. 2009).

Clearly, these authors have found that decisions and policies are more likely to incorporate scientific perspectives if relationships have somehow been established between scientists and decision-makers. However, the strength of the information processing and rational choice paradigms is such that the authors presume this is so because the relationships made for more salient, credible and legitimate information, which in turn led to science being incorporated into decision making, rather than assuming science uptake was simply the result of the relationships themselves.

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101 For details, refer to Appendix 4, Section A4.6.
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Just as Ptolemy had to conjure ‘epicycles’ to make his geocentric version of the universe work, so to have knowledge transfer scholars had to conjure ‘mental models’ to make their Newtonian mind-as-a-computer version of cognitive and social systems work. In both situations, the addition of an ‘extra step’ to reconcile observations with the paradigm leads to theories that are unnecessarily convoluted and which generate paradoxes102. This will be the topic of discussion that follows in Section 7.4.

7.4 Implications for Environmental Management

“The management of complex natural systems as if they were simple scientific exercises has brought us to our present mixture of triumph and peril”


The central role of relationships versus information in decision-making explains why the documented barriers to knowledge transfer are largely linked to culture clashes which impede interaction between scientists and managers, and why there is increasing focus on collaborative approaches to conducting research, such as research for development programs, participatory research, communities of practice, knowledge interfacing and extension (Chapter 3). In addition, it explains why impersonal forms of communication and education, where information exchange is mostly one-way—such as newsletters, factsheets, and meetings and presentations—are largely ineffective, and why education or outreach efforts that provide people with information on a particular issue often have little or no impact on behaviour (Beratan 2007, citing others therein). It also pertains to increasing recognition of the value of using knowledge brokers to catalyse relationships between researchers and practitioners. This is illustrated in Michael's (2009) Table 3.4, showing how the relationship building aspect of the brokering role increases with intended strength of action. From a complexity perspective, social learning in the context of collaborative planning (Chapter 3, Section 3.6.3) appears to supply the best option for successful research uptake, as it is action-oriented, and integrates learning with decision-making, via collaborative processes whereby scientists are part of the decision-making forum.

From the discussions above and in Chapter 6 we can now see how assumptions of the Newtonian paradigm create a paradoxical understanding of knowledge transfer. Knowledge is not an object or thing that can be transferred or exchanged, it is a process of relating. In assuming it is a ‘thing’ one commits an error in logical typing. Supplying people with credible scientific information has limited impact when people seldom make decisions rationally, or consciously apply logic to their thinking. As such, when decisions are made that incorporate scientific perspectives, it is likely that is not because of the credibility or legitimacy of the information supplied to decision-makers. Rather, it is likely because scientists entered into repeated personal interactions and conversations with decision-makers, and through their joint imaginings had a direct influence on reality’s emerging pattern. Thus, by adhering to the assumption that information, rather than relationships, leads to ‘better’ decisions, knowledge transfer efforts become unnecessarily convoluted. Consequently, excessive time and resources are often spent on improving information when they would often be better spent on improving relationships.

However, many research organisations are reluctant to invest in relationship-building activities because they are resource intensive and risky (Beratan 2007). And because the outcomes of such activities are difficult to predict or measure—not least because we often pick the wrong metric, as demonstrated in Section 7.2.2—such investments are difficult to justify in today’s output-focused organisational culture (Beratan 2007). Thus, even though most agencies know impersonal communication has limited impact, they still tend to direct their investments into simple low-cost ‘products’, such as fact sheets, websites and newsletters (Beratan 2007), which can be pointed to and measured as concrete outputs.

102 Another example of a Newtonian convolution is Einstein’s understanding of space-time as a ‘real’ thing (in which the universe sits) that is responsible for the effects of gravity—an understanding which generates the paradox of instantaneous gravitational force. This paradox is resolved by the quantum gravity understanding of space-time as a higher order governing pattern spontaneously emerging from the dynamic interactions of a universe under perpetual construction (as discussed in Appendix 2).
The costs of this error in logical typing do not, however, stop at misdirection of resources that could have greater impact elsewhere. Indeed, this is actually the least of its ill effects. As we have seen in our previous discussions, errors in logical typing create paradox. This leads to errors in problem formulation, which in turn inadvertently generates solutions that paradoxically reinforce or escalate the problem in question. As per Watzlawick et al. (2011) this is the path by which seemingly intractable ‘wicked’ problems are born. In the following sections, I will explore the perverse paradoxical outcomes generated by errors in logical typing, in relation to both knowledge transfer and adaptive capacity.

7.4.1 Knowledge Transfer Paradox

7.4.1.1 Distance in Double Meaning

When scientists say they would like to see their research used by managers and decision-makers to make ‘better informed’ decisions, what they really mean is that they want a say in those decisions, to influence how reality is unfolding, based on what they know103. The mainstream scientific paradigm, however, prohibits the scientist from stating this explicitly, as doing so compromises their privileged stance of objective observer—that of standing outside the system and looking in. Thus, the term ‘better informed’ is a linguistic device, an abstraction scientists subconsciously use to maintain their guise of objectivity, and to distance themselves from the “arena where human beings struggle with one another” (Ong, in Donaldson 2005, p.171). This is a consequence of how scientists have been socialised—to enshrine objectivity and to value only representational knowledge that reflects external reality (Park 1999). Thus, in the name of ‘objectivity’, scientists adhere to representational-referential forms of communication104, which passively represent reality for others to understand (as per Shotter 1994). Then they hope these passive representations will be picked out from the chaotic milieu of rhetoric, power, persuasion and cooperation shaping everyday reality—and be given privilege in decision-making, by virtue of the credibility and accuracy of their depictions.

This ‘strategy of hope’ (as per Roux et al. 2006), however, is only valid if the string of assumptions outlined in Section 7.3.1 hold. As we have seen, this chapter presents strong arguments against these assumptions in favour of an alternative complexity-based paradigm. From a complexity perspective, decision-making is better understood as a process of interacting with other systems, rather than individual information processing. Hence, the term ‘better-informed decisions’ is oxymoronic, and its pursuit a diversion that keeps scientists from achieving their real objective: influence. Ironically, science is thus neutered by its own paradigm. As outlined in our preceding discussions, if scientists want their research to have greater impact on how reality unfolds, they best enter the ‘struggle’ and expand the breadth and scope of their personal interactions to include decision-making domains. This relates to Pielke’s (2007) arguments that the work of scientists who are disengaged from the policy process (e.g. the ‘pure scientist’ or ‘science arbiter’) is only effective in policy situations where there is already broad consensus and low uncertainty. Thus, the cliché ‘you gotta be in it to win it’ applies.

7.4.1.2 Double Bound by Paradox

As with most things, however, this is more easily said than done. Coherent patterns of behaviour in complex systems resist change, and in human systems this translates to powerful interests working to dominate discourse in order to maintain the status quo (as per Foucault 1980). Thus the ‘neutering’ of science is self-reinforcing—by way of research programs that relegate scientists to

103 Which scientists consider to be ‘evidence’, which leads them to also express a desire for ‘evidence-based’ decision-making. ‘Evidence’ is generally understood as that which reveals truth. This understanding clearly relies on Newtonian assumptions of a knowable, external and objective reality. It also reflects the role of evidence in science from the scientific realism perspective. Kelly (2008), however, states that the concept of evidence is inseparable from ‘justification’—evidence is that which justifies belief, rather than that which reveals truth. This understanding is reflected Kuhn’s notion of normal science, whereby evidence is used to justify paradigms rather than uncover reality. Refer to Kelly (2008) for a discussion on the disputed meaning of ‘evidence’ as a central concept in the epistemology and philosophy of science.

104 The impersonalisation and objectification of science has been further amplified by the decontextualisation of concepts afforded by reliance on the written word, as per Donaldson (2005).
the role of supplying information and tools for ‘decision-support’; that measure academic performance in terms of information outputs such as reports and journal articles; and which prohibit scientists from expressing opinions or entering into policy debates\textsuperscript{105}—and all the while increasing demands that scientists demonstrate greater ‘research impact’.

Once again, we have a paradoxical situation created by an error in logical typing—assuming that our clockwork maps of a dynamic, interconnected and emerging territory are more than just navigation tools, that they are the territory, despite our experiences to the contrary. This particular paradox also presents a classic double bind situation (as per Bateson 2000), whereby the rules of a system are such that success in meeting one demand results in failure to meet another, and vice versa. In this case, if the scientist maintains a purely objective stance, he or she will likely fail to achieve substantive research impact; however if research impact is achieved, he or she will have failed to maintain their objectivity. In psychology, double binds are notable for creating impasses and provoking anxiety, neurosis and confusion in those affected; indeed they are frequently employed as a means of subtle control over others (Watzlawick et al. 2011). According to Watzlawick et al. (2011), a key feature of double binds is that the people caught up in them are usually unable to discern the nature of the paradox they are facing. As a consequence, they fail to realise that their problems are generated by the rules or premises of the system itself. Thus any attempts to resolve the bind via logical analysis within the framework of the system (i.e. single loop learning), will only reinforce or escalate this situation (Chapter 6, Section 6.2.10), and so a vicious circle is born (as per Bateson 2000; Watzlawick et al. 2011).

7.4.1.3 Entering the Vicious Circle

A highly simplified summation of the climate change debate can serve to illustrate how a vicious circle is born of an unchallenged underlying assumption in relation to knowledge transfer. As per the string of Newtonian assumptions outlined in Section 7.3.1, many scientists assume that presenting a sufficiently persuasive argument based on the ‘facts’ should influence the beliefs, decisions and behaviours of others. From this assumption, scientists concerned with the lack of action around climate change present a barrage of facts to the public and decision-makers. However, the scientists do not realise that information alone rarely affects people’s behaviours, or that information that conflicts with people’s existing beliefs has the polarising effect of causing some people to change their beliefs, while causing others to reject the new information, discredit the messenger and further entrench their existing positions, as per cognitive dissonance (see Appendix 4, Section A4.4.2.4 for details). Because the scientists have not undergone double-loop learning that recognises or challenges their underlying assumption that facts change people’s beliefs and behaviours, they fail to see that presenting climate facts helped create the denial and scepticism in the first place (via the backfire effect of cognitive dissonance). In absence of this insight, scientists then respond to mounting climate scepticism by presenting more contradictory facts (i.e. they apply single-loop learning). Thus, in absence of double-loop learning, the scientists escalate their error by intensifying a strategy that inadvertently increases rejection of climate science among those they are trying to convince. Therefore, they find themselves entrained in a vicious circle. This takes us back to Watzlawick et al.’s (2011) observation that “failure to resolve a problem doesn’t lie in the impossibility of the task, but in the attempted solution” (p.25). This phenomenon is likewise documented in this excerpt from Beratan’s (2007, citing other therein) review:

\begin{quote}
In fact, additional scientific facts may reinforce value disputes and competing, and more information may lead to more confusion rather than less. Many of these efforts are, in effect, public relations exercises aimed at defusing public resentment rather than genuine efforts to develop adaptive problem-solving processes. Such exercises are counterproductive, as participants quickly figure out whether or not their input is valued. People learn from experience; every negative experience builds cynicism and distrust, and
\end{quote}

\textsuperscript{105}This brings the disturbing trend of scientists being muzzled by democratically elected governments into sharp relief. The recent muzzling of Canadian public scientists is a particularly alarming example (see: http://www.cbc.ca/news/canada/story/2012/03/23/federal-scientists-federal-scientists.html).
increases the difficulty in getting people to participate in future forums sponsored by the same agencies and organizations.

In sum, this example shows how applying the textual notion of ‘knowledge transfer’ as a means of increasing the application of science in behaviour and decision-making is a logical error in problem formulation, which paradoxically escalates the problem it is meant to solve. By replacing our Newtonian assumptions with those of a complexity-based ontology, we can see that active relating, not information, is what drives behavioural patterns, and that decision-making is a process of coordinated interaction between people, rather than individual information processing.

7.4.2 Adaptive Capacity Paradox

7.4.2.1 Adaptive Management – Reinforcing the Problem

However, there is another point of concern with respect to how environmental management problems have been formulated—this time in relation to the logic of the textual notion of adaptive as it is applied in relation to resource management and institutional capacity (see Chapter 1). As we will see in the following discussion, the assumptions underlying the notion of adaptation are also Newtonian, and likewise constitute errors in logical typing when scrutinised from a complexity-based ontology. The following sections will explore how once again this results in serious errors in problem formulation, with unintended paradoxical consequences.

As detailed in Chapter 1, Section 1.3.3.1, adaptive management involves cyclical learning and policy adjustment and implementation (Gunderson & Holling 2002; Gunderson et al. 1995; Holling 1978; Walters 1986). As such, adaptive management is environmental management’s equivalent to Lewin’s action research cycle in organisational development and Drucker’s management-by-objective system in organisational management (Appendix 4, Section A4.3). All three involve designating a desired system objective, then applying a plan-act-reflect cycle of negative feedback to stabilize the system around the selected objective, using participatory methods. Attempting to apply this approach to living self-organising systems, however, is an error in logical typing, as it assumes these systems can be designed and controlled cybernetically, so as to maintain an externally determined system state. This confuses self-organising living systems with mechanical self-regulating systems. As outlined exhaustively in Chapter 6, human systems are dynamically self-organising, and their pattern is a consequence of the co-evolution and harmonisation of a vast multitude of internal and external interactions. The primary imperative of any self-organising system is to maintain its identity, its existing pattern of behaviour. Any attempts to stand outside and design or tinker with such systems so as to make them more ‘more adaptive’—or meet any other external prescription—are likely to meet with either frustration, as the system absorbs any attempts to alter it, or with dismay, as it reacts in unpredictable and potentially undesirable ways. This explains why failure rates of 70-80% are reported in the literature for both adaptive management projects (Medema et al. 2008; Walters 1997), and for change management initiatives in the business world (Burnes 2005; Senge et al. 1999).

However, as was the case for knowledge transfer, the costs of this error in logical typing go beyond just getting poor return on invested resources. In the case of wicked problems, which span multiple system boundaries and domains of governing order, it is the overarching framework of the system—with its accompanying objectives, rules and premises—that is actually responsible for generating the problem situation. Without changing this overarching framework, using adaptive management to tinker with (i.e. cybernetically adjust) the behaviours of any of the parts of the larger system in which the problem is embedded (i.e. doing more, less or variations of the same), will paradoxically reinforce and possibly escalate the problem at hand, as per Galois’ Group Theory (Appendix 2). Analytical policy adjustment and cyclical learning amount to single-loop learning (as per Argyris & Schön 1996), and can only generate first order change (as per Watzlawick et al. 2011).

On the other hand, if adaptive management targets the rules and objectives of a system’s overarching framework (i.e. second order change, via double-loop learning), efforts will be met with

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106 Which are socially generated, thereby making wicked problems social problems requiring social solutions.
distrust and resistance (Argyris & Schön 1996; Brown & Duguid 2000; Stacey 1996a). As noted earlier, this is because second order change threatens the higher-order governing pattern that constitutes a system’s identity. Indeed, concerted attempts at creating second order change will likely provoke embarrassment and defensiveness among a system’s members, and inadvertently generate counterproductive anti-learning patterns (Edmondson & Moingeon 1999), and entrenchment of existing behaviours, as per cognitive backfire (Nyhan & Reifler 2010). As Meadows (1999) observes, the ‘higher’ the leverage point used to try and change a system, “the more the system will resist changing it—that’s why societies tend to rub out truly enlightened beings” (p.19). Many of the barriers to building adaptive institutions summarised in Chapter 1 are the consequence of homeostatic forces at work in coherent systems. Thus, because adaptive management constitutes an error in logical typing, it is likely to either be relatively ineffective or to paradoxically reinforce the problem it is trying to correct, inadvertently creating a vicious circle.

7.4.2.2 Adaptive vs. Creative Capacity

The ultimate aim of environmental management is to see that the earth’s biophysical resources are used and managed sustainably, meaning they will not be depleted in the long term, thereby ensuring our own long-term survival. As outlined in Chapter 1, it is assumed that this will be achieved via adaptive governance—improving the adaptive capacity of our institutions so as to make them more resilient. By this it is assumed that human systems will be better ‘adapted’ to their environments if there are strong feedback loops between society and the environment (Folke et al. 1998; Hanna et al. 1996), allowing for adaptive management (Berkes et al. 2003). It is then presumed that detecting and responding to environmental feedback (adaptive management) requires knowledge and understanding of resource and ecosystem dynamics (Folke et al. 2005). Hence, it follows that knowledge transfer is a feedback mechanism that helps confer institutions with adaptive capacity, which in turn will ensure these systems operate in balance with the environment, which will in turn ensure that we do not deplete our biophysical environment to our long term detriment. These are the assumptions that formed the conceptual framework and the problem statement for this study at its outset. Indeed, at the study’s inception I framed adaptive capacity as the collective ability and willingness of institutions to use research and modelling feedback to influence their decisions.

From a complexity-based ontology, however, there is no outer reality to which an individual system must adapt. To treat the ‘environment’ as a pre-given background entity is an error in logical typing. What we distinguish as a system’s ‘environment’ is actually the vast fabric of nested dynamic interactions, of which the system is a part, that together are perpetually co-creating reality. Any sense of separation between the system and its ‘environment’ is an illusion wrought by the scale of observation (Chapter 5, Section 5.5). The main imperative of these networked systems is maintaining their circular pattern of organisation (i.e. identity) whilst they interact—they have no interest in sustaining their ‘environments’ as no such thing exists. Thus, reality is the pattern of jostling tension that emerges from their conflicting and cooperative identity-conserving interactions.

The greater the number and diversity of couplings between these systems, the larger the domain of possible interactions they may enter into (Chapter 6, Section 6.2). This in turn increases the domain possible futures they may create. This is better understood as conferring the system with plasticity or creative capacity (via two-way interaction), rather than conferring it with adaptive capacity—which denotes its capacity to read or change (via one-way interaction).

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107 From a complexity perspective a living system’s imperative is maintaining its identity—its existing pattern of circular organisation. This is a subtle but important distinction from the Darwinian assumption that a living system’s imperative is survival. Thus, we cannot make external determinations that an organisation must change its pattern in order to survive, or fit better with its environment. Because from the organisation’s perspective, change is death—the death of its present identity or pattern of organisation, which it will intrinsically resist.

108 This resonates with Margulis’ (1989) arguments against life adapting to a passive environment and Lovelock and Margulis’ (1974) Gaia theory (Appendix 1, Section A1.6.3).

109 Gunderson and Holling’s (2002) concept of panarchy captures the complexity-based understanding of systems as dynamic nested interactions, both creative and destructive, but retains a ‘flattened’ Newtonian focus on system change and adaptation—i.e. systems adapting to reality, rather than co-creating reality.
As described in Chapter 6, Sections 6.2.5 and 6.2.6, being able to use language to share and coordinate our imaginings of the future has enabled humans to enter into increasingly complex and ordered patterns of interaction. As outlined in Chapter 6, Section 6.3.11, the result is an increasingly complex society, wrought by our increasing connectivity. This has created vast and complicated global supply chains that have ‘strung out’ the feedback loops that connect members of industrialized societies with life-sustaining biophysical resources. We are no longer pre-occupied with basic survival. This has allowed our every-day attention to largely shift away from the biophysical environment—hence most of us no longer directly couple or interact with many aspects of it. Instead, our attention and interactions—aided by technology and the Internet—are now focused on increasingly abstract social imaginings and constructs, which become self-sustaining over time. Because attention\(^ {110}\) is like fertilizer—it makes phenomena grow—this serves to further increase the domain and complexity of higher order socio-economic governing patterns. Which in turn further separates us, spatially and temporally, from the biophysical resources that sustain us.

These higher order socio-economic patterns are so plastic and resilient—by virtue of their complexity and global connectivity—that they have, so far, spontaneously resolved strains on resource supply by creatively intensifying or shifting resource extraction, by way of technological and social innovations etc. In so doing, members of industrialised economies evade the constraining negative feedback that would succeed in entraining/harmonising more simply-ordered social systems into the circular governing patterns of biophysical systems.

### 7.4.2.4 Engineering Information-based Feedback

Adaptive approaches to management and institution building aim to artificially bring about this entrainment/harmonisation by re-establishing more direct cybernetic feedback loops between human society and the biophysical environment. This is often conceived as improving the supply of scientific information for decision-making, or designing institutions to incorporate scientific knowledge in cyclical learning and decision-making cycles.

However, as discussed above, artificially engineered information-based feedback loops are not likely to succeed in short-circuiting the complex higher order governing patterns that drive societal behaviour, and may indeed exacerbate the problems they are intended to resolve. Human thinking and behaviour is not driven by conscious information processing and rational decision-making, as is assumed by the Newtonian mind-as-a-computer paradigm. As detailed in Chapter 6, Section 6.2, behaviour, communication, language, learning, imagination and all other social phenomena are just extensions of dynamic embodied cognition—stable higher order patterns of interaction that spontaneously emerge from iterative couplings between living systems.

As previously stated, it is relationship not information that drives system behaviour. When we attribute the erosion of sustainability to poorly-informed decisions, or poorly designed institutions, we commit a logical error in problem formulation. Global sustainability issues are part of the dynamic pattern emerging from a vast complex of historic interactions, of which we are part. Assuming that the behaviour of self-organising systems can be changed by design, prescription or information is an error in logical typing. Attempting to do so spawns paradox-generating strategies, such as knowledge transfer and adaptive management.

### 7.5 Reframing the Ningaloo Study

“The uncreative mind can spot wrong answers, but it takes a creative mind to spot wrong questions.”

—Antony Jay (1968)
The concept of resilience (Walker et al. 2002)—which assumes that the ability of socio-ecological systems to weather disturbances is partly a function of their ability to learn and adapt—was the fundamental underlying framework for this study. As such, my core assumption at the study outset was that the adaptive capacity of institutions responsible for governing natural resources is reliant on their ability respond to feedback from the socio-ecological system they are attempting to manage, and that knowledge transfer is a mechanism for enhancing such feedback. In the previous sections, hypothetical examples were provided to show how ‘textual’ notions of ‘adaptive capacity’ and ‘knowledge transfer’ cause logical errors in problem formulation, with paradoxical results. I will now look at the linguistic construct of knowledge transfer in relation to the rationale, design and outcomes of the Ningaloo action research study (as outlined in Chapters 1-4), starting with a brief recap of the study outcomes detailed in Chapter 4.

7.5.1 Recap: Ningaloo Action Research Study

The Ningaloo study began with a review of the environmental management literature to identify critical success and failure factors associated with building adaptive institutions (Chapter 1), and to devise a conceptual framework for knowledge transfer (Chapter 3). The knowledge transfer barriers and opportunities identified by Ningaloo stakeholders in the initial interviews I conducted for the action-research component of this study (Chapter 4, Appendix 6) were largely consistent with those identified in these reviews. Both the literature and the stakeholder interviews suggested that knowledge transfer would likely be more successful if it involved significant stakeholder engagement and relationship building between researchers and research recipients. I made this the central assumption of my conceptual framework.

I then used the initial interview findings to help inform a collaborative, multi-agency knowledge transfer effort to promote the NRP’s research findings and modelling tools in the Ningaloo region (Chapter 4, Appendix 7). Based on the conceptual framework in Chapter 3 and recommendations from the initial interviews, our knowledge transfer efforts focused strongly on stakeholder engagement111. Indeed, roughly 43% of the modelling researchers’ project time was spent on stakeholder engagement (details in Fulton, Jones et al. 2013, Appendix 8). This was in addition to the 18-month duration I spent living and serving as a knowledge broker in the Ningaloo region, to help foster relationships and communication between the NRP’s modelling researchers and regional stakeholders.

Six months after the knowledge transfer process was completed, I conducted a final round of interviews, to gather stakeholder and researcher perspectives on how effective the process was, and to evaluate how the process affected their knowledge (Appendix 11). As discussed in Chapter 4, based on these interviews, the sampled regional stakeholders (bearing in mind there were only eight) appeared to have gained less representational knowledge112 (i.e. facts and figures) than was expected. This is exemplified by these two local responses to my question ‘do you know anything now that you didn’t before?’:

“It should be an easy question, shouldn’t it?…Well, I’m not sure in terms of knowledge,”(p.16)

“Ooh, wow…. [It’s turned out to be a tricky question.] Yeah. Oh, goodness… Well, I guess it’s connected us better and myself better with various bodies and things…. Nothing else is springing to mind.” (p.16)

In addition, there were no reports of regional stakeholders having yet used the models they had been trained on, as indicated by this response from one of the interviewed scientists:

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111 The bulk of the stakeholder engagement was conducted after most of the research had been already completed. Engagement during the actual research design and implementation phase was limited, with some exceptions. As such, the research itself was not participatory, but knowledge transfer process was.

112 As defined by Park (1999) representational knowledge is a ‘faithful’ quantitative depiction and explanation of reality, such that people are better able to control that reality (see Chapter 3, Section 3.5.1).
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“… in the six months since my project’s finished, I haven’t received any enquiries from anybody about using the model. So, you know, even though I think we did a reasonably good job, if we’re looking at uptake, something hasn’t happened.”

“So, even though I think that the engagement process was certainly enriched by your involvement and all the effort we put into it, there still seems to be something not quite ticking over.” (p.58)

Thus, despite substantial investment into stakeholder engagement and knowledge brokering, the knowledge transfer process appeared—on the basis of this limited sample size—to have failed at delivering as expected on its objective—that being to transfer scientific information to stakeholders, and see them use it during decision-making (as per Roux et al. 2006). As such, the study results did not support my conceptual framework (Chapter 3), which was centred on the assumption that knowledge transfer is more likely to be successful (in terms of research being understood and applied) if it focuses on stakeholder engagement and building relationships.

However, because I had encountered Park’s (1999) knowledge typology during my ongoing literature review, I had designed the evaluation questions to test for the emergence of relational and reflective knowledge113, as well as for representational knowledge. Relational knowledge pertains to the relationships people have with one another, whereas reflective knowledge refers to the raising of consciousness and conscience, and the application of values to instil conviction and generate action. According to Park (1999), both facilitate the sharing of representational knowledge.

The responses to these added questions suggested that the knowledge transfer process did appear to affect interviewees in two unexpected ways. Firstly, there were indications that the process helped strengthen and/or expand the network of relationships both between regional stakeholders, and between stakeholders and researchers. There were also indications that it improved the perceived quality of those relationships. Secondly, most of the interviewees reported that they had gained some appreciation for the value of face-to-face engagement and informal relationship building, and signalled their intentions to apply these types of processes in their own work. Thus, the interview results suggest that the knowledge transfer process inadvertently generated relational and reflective knowledge instead of the intended representational knowledge. The interviewees indicated that these outcomes were a result of the relationships they established during engagement efforts. Although these relationships had persisted in my absence, stakeholders indicated they had diminished somewhat (the research coordinator did not continue hosting meetings after I left the region), suggesting that there is a risk they will fade in absence of a catalysing presence that works to maintain them. In Chapter 4, I suggested that this expanded network of relationships could perhaps represent some improvement in the adaptive capacity on the Ningaloo region (as per Berkes & Folke 2002a; Berkes & Folke 1998; Blann et al. 2003; Gadgil et al. 2003; Gunderson et al. 1995; Kendrick 2003; Lee 1993; Low et al. 2003; Pahl-Wostl et al. 2007; Schianetz et al. 2007; Tengo & Hammer 2003), despite the apparent failure in transferring and applying representational knowledge. This apparent disconnect between the generation of adaptive capacity (in terms of connectivity) and representational knowledge caught my attention. It seemed paradoxical to me, given the assumptions of my conceptual framework.

7.5.2 Reframing Knowledge Transfer Results

As outlined in Chapter 1, Watzlawick et al.’s (2011) Principles Of Problem Formulation states that seemingly intractable problems can only be solved by surfacing and discarding old assumptions and establishing new starting points for reasoning. Thus, after completing the evaluation interviews and conducting a preliminary thematic analysis on them, I made the difficult decision to abandon my data, and undertake instead a theoretical exploration of the assumptions underlying my conceptual framework. In this way I hoped to better understand the paradoxical outcomes of the Ningaloo study, and why so little representational knowledge was generated despite the intensity of stakeholder engagement and the relationships that were formed as a result.

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113 Refer to Chapter 3, Section 3.5.1 for details.
In her knowledge transfer review\textsuperscript{114}, McNie (2007) states that we have little understanding of decision processes and lack a framework for understanding them. She also suggests that the problem of research uptake can be resolved by improving the usefulness of scientific information for decision-making. The theoretical investigations outlined in Part III of this thesis, however, suggest that it is relationships and patterns of interaction—not information processing—that directly drive most decisions and system behaviour. Park’s (1999) notion of relational knowledge, despite his treating it as a ‘thing’ rather than a process of interacting, captures this. Part III’s investigations also suggest that analytic application of scientific information is a form of single-loop learning, which, in the case of intractable or wicked problems, often exacerbate the issue under question. In addition, they indicate that providing people with information that contradicts their existing beliefs often causes them to become hostile and entrench their existing behaviours, as per cognitive backfire. This is a particularly relevant concern in the Ningaloo region, because of widespread anti-science attitudes forged by past resource-use planning conflicts.

Reflection, on the other hand, is more likely to generate insight and second order change. Park’s notion of reflective knowledge likewise captures this. In the Ningaloo study, stakeholders’ reflections on the engagement process led them to see that establishing informal relationships could help them achieve their own objectives—through realisation of previously unthought-of cooperative opportunities, and by overcoming some of the historic divisions impeding cooperation between regional groups and agencies at the time of the study. This is illustrated by the following local stakeholder responses to the question ‘are you doing anything differently as a result of the knowledge transfer process?’ (Appendix II):

“The’s been more openness to hearing the conservation point of view and also been more willingness from the conservation side to share knowledge that’s available. So some of the barriers have been overcome as a result of people just being open and sitting down and approaching it in a professional manner as opposed to getting emotional about their own sides or viewpoints. I think that’s certainly led to a difference in the way our group’s approached and we’re more likely to share information than previously.” (p.27)

“…the best outcome for me is that it [the knowledge transfer process] has produced a network I didn’t have before. So, that’s sort of an indirect outcome of this whole thing. (p.27)

“I think the liaison and communication has been the key outcome that I can see from it and awareness of other people’s interest and knowledge has been good.” (p.27)

“Well, I guess it’s connected us better and myself better with various bodies and things, and that’s been good, because those connections are important, you can always link into contacts then if you get to know people personally, it makes it much easier. And I think that’s been a real plus, having contacts like Beth and Todd and others. They’re really good connections. Because sometimes you know where you want to be but you don’t quite know who to gather to get there. So that’s been helpful, I guess, and is something that wasn’t there before.” (p.16) [this statement was actually in response to the question ‘do you know anything now that you didn’t before?’]

The scientists who responded to this question likewise indicated that the process had caused them to increase the value they placed on stakeholder engagement, and influenced how they saw their roles. For example:

“The way that I’ve managed research, my understanding of what it means to engage, the way I communicate my research—they’re massive things really.” (p.24)

“…I wouldn’t say for every single member of the modelling group but for those who seriously want to make an effort and make a change and impact, it has significantly

\textsuperscript{114} Refer to Chapter 3, Section 3.4.1 for details.
changed the way we do things. (So you guys now view the stakeholder interaction and learning as a critical component to seeing research impact or modelling impact? Yep.” (p.24)

“...on the scientists part, they’ve got to appreciate that if we were ever held up as these gods that when we spoke people listened and accepted what we said, then that world is certainly long gone. I’m not sure it ever really held up. I think it was a myth that grew out of the early 20th Century, and it’s just that it’s being driven home more that that’s not true now, and the scientists need to change the way they’ve been communicating.” (p.43)

This result was consistent with interviews conducted by Syme et al. (2012), for the Ningaloo Client Outreach Project115, which also indicated that some NRP scientists were re-evaluating their roles in terms of the need for broader community engagement. It should be noted, however, that my interviews showed that scientists largely saw stakeholder engagement as a means of improving the saliency, credibility and usefulness of scientific information and modelling tools (as per McNie 2007), i.e. for information processing, rather seeing the interaction itself as a means of directly influencing behaviour and decision-making patterns in the region.

All of the interviewees reported that their network of relationships had either been extended or improved in some way by the knowledge transfer process (although two indicated that the change was quite small). Groups that were reported to have improved relationships with other stakeholder groups included: regional office of the Department of Environment and Conservation (DEC), the NW Cape Conservation Group (CCG), the Centre for Whale Research, the Shire of Exmouth, the Gascoyne Development Commission (GDC), and the modelling researchers from the Ningaloo Collaboration Cluster (NCC). These were the groups that had the most face-to-face interaction during meetings and workshops held during knowledge transfer process. For example, when I asked interviewees how their relationships had been affected by the knowledge transfer process, the following responses were supplied (Appendix II, pp. 35-37):

“‘Yes, there are some differences—the lunch meeting that you arranged has certainly strengthened ties between stakeholders, so that’s had a positive influence.”

“I think CCG’s relationship with Shire has really strengthened recently. [With the reference group meetings you mean or the…] With the reference group meetings, probably one of the strongest ties is actually sitting down and listening.”

“I think it’s a bit too early to say if the local connections will continue into the future so at the present moment they seem to…. But at the present moment it does look like a degree of local connection is much stronger than in the past.”

“Yes, certainly with DEC locally. Definitely creating a better relationship there and I think not just the Shire and DEC, but the community and DEC. And I think that’s the beginning of a better relationship so we hope that that will improve and increase…It’s been lacking before…”

“When I do have questions, it’s relatively easy now to call someone and ask for help. Because I’m not a specialist in environmental questions or topics, but I can now call [locally based scientist].”

This last statement is an important point. Rather than referring to information generated and conveyed during the knowledge transfer process (e.g. from websites, reports and presentations), the interviewee states that instead they directly contact the human source of that information—the scientist. This is consistent with the discussion in Chapter 6, whereby it is argued that ‘knowledge’ of a system is better understood as a function of its internal and external connectivity (i.e. relationships between its agents, which confer the system with creative capacity), than as the amount of information held inside the heads of its individual members. Based on this understanding, the

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115 See Chapter 4, Section 4.2.5.2.
improved and expanded network of relationships in the Ningaloo region that resulted from the knowledge transfer process\textsuperscript{116} implies an increase in the system’s ‘knowledge’, irrespective of whether or not individual members gained representational knowledge. The importance of these reported improvements in relationships between Ningaloo stakeholders is particularly relevant given the history of tension between the regionally-based agencies, and between scientists and the local community.

Thus, due its focus on stakeholder engagement, it appears that the knowledge transfer process might have inadvertently produced effects that are potential precursors to true system change. As outlined in Section 7.4.1, scientists are more likely to influence a system’s behaviours via establishing relationships and actively connecting with other components of the system, than they are by passively supplying information to others\textsuperscript{117}. This gives credence to Lomas’ (2007) earlier noted contention that “human interaction [is] the engine that drives research into practice.” If the project had succeeded in transferring representational knowledge, this may have paradoxically reduced acceptance and application of scientific knowledge (e.g. Beratan 2007), because of pre-existing negative attitudes toward research. The potential for this effect was indicated in one interviewee’s observation that some local residents devalued the legitimacy the NRP’s research projects after attending a public research presentation that contradicted local views of the situation (Appendix II):

“There was one project that unfortunately was one of the ones presented publicly that really caused a lot of skepticism amongst locals, which was a shame because it did devalue the legitimacy of the other projects. The one about crayfish that said there’s only a couple of crayfish caught in this huge area, I can’t remember the exact figures, but it was some tiny amount of crayfish in comparison to historical records of... and because the talks were about fish, there were quite a few fishermen present and having done crayfishing themselves, were very skeptical about those results.” (p.56)

Thus, from a complexity perspective, the Ningaloo knowledge transfer process did appear to begin creating the kinds of effects that could potentially influence governance patterns and help harmonise the activities and interests of wider range of stakeholders, including scientists. However, had I conventionally designed the evaluation interviews to test only for uptake of representational knowledge, this would have been missed, and the process would have been measured as a failure.

7.5.2.1 NRP Client Outreach Project

This notion of connectivity being a better measure of assessing a research program’s impact than actual (representative) knowledge transfer is reflected in the approach taken by the NRP’s client outreach project\textsuperscript{118} (Syme et al. 2012). Syme et al. (2012) used effectiveness of communication between scientists and other stakeholder groups in the region as their indicator of science uptake success. If one takes communication effectiveness as a measure of system connectivity (rather than information exchange), their project design was more in line with a complexity perspective than was mine. Their network analysis\textsuperscript{119} found that while the NRP’s research community was internally well connected (i.e. there were strong connections between scientists), which is beneficial in terms of fostering transdisciplinarity, the science community was relatively isolated from other stakeholder groups. The authors state that such functional network holes will “defy the best attempts for getting science and modelling used for science-based decision-making” (p.100). Their conclusion is consistent with the complexity perspective on research uptake that I have outlined above.

\textsuperscript{116} It should be noted, however, that in the latter stages of this project, changes in the heads of most of the key government agencies operating out of Exmouth helped ‘warm’ the relations between these groups, and created some optimistic signs of future cooperation that were absent at the beginning of the study.

\textsuperscript{117} It should be noted that one interviewee expressed disappointment at the amount of scientific information that was communicated, and would have liked the knowledge transfer effort to focus more on communicating detailed research results (Appendix II).

\textsuperscript{118} See Chapter 4, Section 4.2.5.2.

\textsuperscript{119} Their project did not involve a before and after research/knowledge transfer network analysis, hence relative changes in the Ningaloo network were not measured.
7.5.3 Reframing Knowledge Brokering Results

When viewed from a complexity-based perspective the value of using a knowledge broker to help catalyse relationships between scientists and decision-makers becomes apparent. This is particularly so given the historic cultural clash between managers and scientists and the difficulties many scientists have in communicating with non-scientists (Roux et al. 2006). This is exemplified by a comment made by one of the scientists interviewed in my first round of interviews:

“Scientists don’t all believe it’s their responsibility to translate their work into community terms. They don’t see it as their role, or they don’t have time, or they don't know how. They don’t know how to do certain things, like communicate or run workshops, so they disregard them, rather than asking someone to help them or to collaborate with. I don’t know how to communicate, so I’m not going to.” (Appendix 6, p.23).

Knowledge brokers can help scientists successfully communicate and relate to others, particularly when scientists lack the time, capacity or willingness to do so on their own. This aspect of the knowledge brokering role was noted by some of the scientists interviewed at the end of the Ningaloo study (Appendix 11):

“I think the way that we ran the meetings in the region was a big improvement. Your own skill set was, I think, quite important in terms of improving the presentations and making sure they were clear” (p.81)

“…but I think having you in the region improved our engagement with the region, I would say that. I think it gave us a much better insight into what the local community was thinking, in particular it was very helpful to engage with people about what they wanted to see in the presentations—I think that was really important, because it gives people a sense that we’re addressing some of their concerns.” (p.80)

A number of other stakeholders interviewed at the end of the project also indicated they saw value in my knowledge brokering role in terms of how it facilitated relationships between different groups operating in the region. For example:

“[…]So rather than me actually transferring knowledge you saw me as facilitating it; is that correct?" Yeah, for example you let other people know about us, you let us know about other people, you brought other people to us, you let us tell our story to you and in that way our influence, knowledge and awareness increased rather than decreased which was very valuable because we’re on the ground and don’t have the resources to move or work in arenas that you access, and through you, we could get information when we needed it. It felt inclusive, not exclusive.” (p.78, Appendix 11)

Thus, by catalysing new or renewed connections between different groups, a knowledge broker can be used to help increase the creative capacity (i.e. plasticity) of socio-ecological system such as Ningaloo, as well as increasing the creative capacity of scientists themselves.

7.5.4 Reframing the Role of Modelling Tools and MSE

The focus of the NRP’s multi-agency knowledge transfer effort was largely to encourage regional uptake of its modelling tools. However my results, as well as an assessment undertaken by Jones, Wood, et al. (2011), indicated that the modelling had also helped strengthen social networks and group learning in the region. Nonetheless, the primary intended use of modelling tools and management strategy evaluation (MSE) is typically decision support when dealing with complex systems, to help decision-makers and managers become better informed and make ‘better’ decisions

Despite this, the modelling tools were also found to have value in other ways. For example, the modelling was found to help improve the communication between scientists and decision-makers, and to help increase the creative capacity of both groups. This is exemplified by a comment made by one of the scientists interviewed in my first round of interviews:

“I think the way that we ran the meetings in the region was a big improvement. Your own skill set was, I think, quite important in terms of improving the presentations and making sure they were clear” (p.81)

“…but I think having you in the region improved our engagement with the region, I would say that. I think it gave us a much better insight into what the local community was thinking, in particular it was very helpful to engage with people about what they wanted to see in the presentations—I think that was really important, because it gives people a sense that we’re addressing some of their concerns.” (p.80)

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Thus, by catalysing new or renewed connections between different groups, a knowledge broker can be used to help increase the creative capacity (i.e. plasticity) of socio-ecological system such as Ningaloo, as well as increasing the creative capacity of scientists themselves.

120 Although it should also be noted that a number of issues were also raised in relation my knowledge brokering role, notably distrust of the position, given I wasn’t affiliated with a particular agency and didn’t have a mandate, and insensitive handling of these concerns (Appendix 11).
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by overcoming humans’ ‘bounded rationality which results in ‘suboptimal solutions’ (Fulton, Gray, et al. 2011, citing others therein).

This intent is premised on the Newtonian assumptions that decision-making is driven by rational information processing, and that there is an external independent reality about which we can theoretically gain complete knowledge. The models used in MSE are the computer equivalent of cognitive mental models. They are representations of reality used to play out the consequences of different decisions prior to trialling them in real life. In Chapter 6, however, I presented complexity-based arguments that challenge these Newtonian premises and assumptions. Just as rational and analytical decision-making is in actuality seldom employed during cognitive processes (we mostly act unconsciously), so too is the type of rational decision-making that MSE is intended to support.

When these Newtonian assumptions go unchallenged, there is a danger of using computer models to address complexity by developing ‘ever more sophisticated methodologies’ (to pretend) to capture, manage and control it, without also engaging in the wide-ranging, ongoing dialogue that confers a system with the plasticity—or creative capacity—needed to break out of old patterns and create novel futures. Meppem and Bourke (1999) argue that when a complex environmental issue is shrunk into a computer simulation, the “simulation then becomes a ‘world view' that reinvents itself”, and in defining its boundaries abstracts the problem from its social complexity.

So if the primary means of improving the ‘knowledge' and creative capacity121 (in the complexity sense) of the Ningaloo system is via improving and expanding the network of relationships between different stakeholder groups, what then is the role and value of the NRP’s modelling tools? Jones, Wood, et al. (2011) suggest that modelling has the capacity to assist with collaborative planning and building regional resilience. Schianetz et al. (2007) likewise state that modelling can contribute cooperation and collaboration between disconnected groups. However, the principal objective in both these modelling perspectives remains that of integrating information and providing decision-support via group learning.

The modelling and role-playing work done by D’Aquino et al. (2003) has a different emphasis. In this case, the modellers fully included stakeholders in the modelling design, process and usage, an approach consistent with the centrality of relationships in a complexity-based paradigm. The intensive role-playing engagement used in D’Aquino et al.’s process creates the iterative dialogue and interaction among stakeholders needed to explore options and improve their collective decision-making capacity, i.e. it creates the necessary conditions for emergence of new behaviours. D’Aquino et al. argue that such self-designed and empowering (i.e. self-organising) modelling processes are more likely to lead to better governance of resources than expert-built models generating specific resolutions for complex problems, which may or may not be taken up by decision-makers. From their perspective, it becomes less a question of whether or not the models accurately depict all the stakeholder viewpoints, behaviours and cultural assumptions (e.g. as per Dray et al. 2006), and more a question of whether or not the process of developing and using the model has created the necessary empowerment and interactions between agents in the system to generate the emergence of new patterns of decision-making behaviours122. D’Aquino et al.’s (2003) work shows that it was not the accurate capture of cultural preferences of different stakeholder groups in their model that led to it actually being implemented. Rather, it was the participatory design of the model that brought stakeholders together, and the ensuing dialogue, trust and relationships that developed between them that led to experimentation with new ways of managing the resource.

121 Recognising that any novel patterns of interaction that emerge as a result will be unpredictable, and potentially undesirable from certain standpoints.

122 This distinction relates to Goldstein’s (2009) observation that those in the field of socio-ecological resilience typically apply deductive research approaches to find generalizable rules and falsifiable propositions about human behaviour that explain how collaborating agents arrive at rational choices (see Appendix 4, Section A4.2). In contrast, those in the field of communicative/collaborative planning apply social-constructivist approaches (see Appendix 4, Section A4.4.3) to search for meaning in people’s interactions, rather than rules—they look at how the social process of collaboration fosters transformation in identity, knowledge and institutions (Goldstein 2009).
In other words, the model does not change institutions, behaviours or practices—it is the dialogue and relationships between agents in the system that create change. As such, MSE models can be used as a catalyst for generating dialogue and creating relationships among stakeholders, thereby perhaps imbuing a socio-ecological system with greater connectivity and therefore creative capacity. Used in this way, computer models essentially serve as extensions of people’s imaginations, helping present their visions of a possible future. This in turn expands the domain of possible interactions they may enter into, which further expands the system’s creative capacity.

The success of D’Aquino’s self-designed modelling process supports tentative conclusions made in Chapter 4, that the lack of research uptake in Ningaloo was perhaps due to the scientists undertaking most of the stakeholder engagement at the end of the research process, rather than consistently engaging and involving regional stakeholders in the entire research process\(^\text{123}\). It also explains why a number of Ningaloo stakeholders expressed positive effects of the modelling training workshops in in terms of the relationships and networks they gained as a result, rather than as enthusiasm for using the models themselves. This is illustrated in a comment made by one local stakeholder who underwent the training:

“I still think that the model itself is quite complicated for non-specialist users. But, that might just be the way it is I think. Like I’ve said a few times now, *I think what worked is bringing people together but I know that’s not the aim of the program* [emphasis added] but I think that’s still an important spin-off. I think it was good that they came here to do the training and made an effort. I don’t know if there’s anyone who has actually used the model since but, I think it’s still worthwhile to at least have tried it.” (p.57, Appendix 11)

The heart of the knowledge transfer paradox is revealed in this individual’s statement: *I think what worked is bringing people together but I know that’s not the aim of the program*. They were correct—bringing people together was not the aim of the knowledge transfer and modelling efforts. But it should have been.

7.5.5 **An Error in Problem Formulation**

This leads me back to Watzalwick et al. (2011), once again, and their observation that “failure to resolve a problem doesn’t lie in the impossibility of the task, but in the attempted solution” (p.25). Based on the discussions in this chapter we can now see that the common failures encountered when trying to increase science application (as outlined in Chapters 1 and 3), such as those that presented in the Ningaloo action research study, are quite possibly a result of applying knowledge transfer as the attempted solution.

The ultimate aim of the Ningaloo research program was to see its research results applied so as to effect more sustainable decision-making in the region. At the outset of this study, I unconsciously held the Newtonian assumption that decision-making is a form of conscious information processing. I then compounded this assumption with another: that research application in decision-making is achieved through (representational) knowledge transfer. I then formulated my problem statement and research questions around improving knowledge transfer. Consequently, from the perspective of a complexity-based paradigm, this study became a classic example of an error in problem formulation.

7.6 **The Escape Route: Reformulating the Problem**

“All fights for true change begin with the ability to envision a different future. Through this lens, imagination—the ability to craft new ideas, images, and possibilities—is a core element of all meaningful work for social, cultural, and political transformation.” —Reinsborough (2010)

\(^{123}\)It should however be noted that D’Aquino et al.’s (2003) modelling work was done in Senegal, and did not have to overcome the highly entrenched behaviours of large complex bureaucratic systems that characterise industrialised countries such as Australia. In my own experiences working on sustainability initiatives in Nigeria, I was frequently astonished at how quickly rural communities would make quite radical social changes.
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As outlined above, in response to my action research study’s failure to confirm its conceptual framework, I undertook an in-depth theoretical exploration of the assumptions and premises underlying the framework. An alternative, and perhaps more ‘normal’, reaction to this failure would have been to assume that the theoretical framework was correct, and focus my efforts on rationalising the disconfirming results as being caused by my study design, not having had enough participation, and/or ‘contaminating’ effects from outside forces. This would have been a reasonable decision—particularly given the small sample size of evaluation interviews—and these factors cannot be ruled out as determining factors in the study outcome. But the high failure rates of knowledge transfer efforts cited by the literature and in my own professional experiences deterred me from this route, prompting me to ‘dig deeper’ instead.

The approach I took was no doubt the path less travelled (as per Kuhn 1962). And given its convolutions, uncertainties, risks and challenges, I can certainly see why ‘travellers’ in the scientific discipline seldom tread it. However, as the previous discussions in this chapter demonstrate, neglecting that path “bent in the undergrowth” (Frost 1916) has potentially serious consequences, the generation of intractable or wicked problems among them. It also creates methodological concerns124. For example, when experimental results fail to support a particular theory, often times contaminating effects—the unforeseen and therefore uncontrolled variables believed to disrupt the workings of the theorized system’s behavior—rather than the theory itself, are blamed. A frequent response is to further isolate the system being tested, to close it off from these ‘contaminating’ variables. But this can be a perilous approach when dealing with complex systems, as it fails to acknowledge that the behavior any given complex phenomena is the emergent result of a multitude of interacting variables, which cannot be abstracted from surrounding systems without disrupting the behavior itself (see Funtowicz & Ravetz 1993). Trying to explain unexpected behaviours in complex systems by further isolating them creates a reductive spiral, whereby the patterns of relationship that give a system behavior “life”125 are paradoxically severed by attempts to better understand that behavior by way of breaking the system down into pieces126. This is yet another case of confusing the map with the territory (confusing the theory with the actual pattern of interactions it is meant to represent)—and the methodological equivalent of trying to understand the behavior of an organism by dissecting it, therein causing it to die (Capra 1997).

While undertaking the theoretical explorations for Part III of this thesis I attempted to separate the old ‘map’ I had been using (Chapter 3) from the territory it was meant to represent. On finally recognising the ‘here be dragons’ warnings as mythical rather than actual limits to my academic quest, I crumpled up this map and drew a new one (Chapter 5) as I ventured across unexplored (by me) theoretical and philosophical ground. With this new complexity-based map in hand, how then can scientists avoid paradox and apply their research so as to have greater influence on decision-making?

When we become entrapped by our assumptions, or habits of thought, they are extremely difficult to escape from, as they prevent us from recognising proof that our beliefs may be false or inaccurate (Shotter 1994, citing others therein). Watzlawick et al. (2011) observe that people who manage to escape double binds or otherwise paradoxical situations, usually do so through sudden insight. This insight typically appears as a ‘jump’ to a weird or counter-intuitive solution, which often applies itself to previous attempts at solving the problem. Indeed, this was the case for me, when a sudden insight around the scale dependence of chaos and its unifying effect helped me frame the complexity-based ontology I synthesised in Chapter 5. As discussed earlier, this ‘jump’, or insight, provides a route out of the system, allowing those caught to escape the framework of rules, premises and assumptions responsible for generating the problem situation to begin with.

This notion of ‘mentally escaping’ a system’s boundaries also resonates with Shotter’s (1994) argument that such entrapments are not caused by the true nature of ourselves or reality, but rather

124 Also see Cilliers’ (2005) notion of incompressibility in complex systems.
125 ‘Through emergence, as per Chapter 5, Section 5.3.7.
126 In Section 7.2.2 I make the argument that this application of reductionism is wrongfully premised on the Newtonian assumption that cause-and-effect can be quantified across chaotic system boundaries.
by the literary and textual ways we have formulated our problems. For example, scientists wanting to escape the double bind presented in Section 7.4.1 can do so, either by accepting that it is indeed a “participatory universe” (as per Wheeled, in Capra 1997, p.141), and abandoning their objectivity in favour of connecting with others and adding their rhetoric and vision to the conversation; or by maintaining their objective stance, and abandoning their attempts to improve their research impact by way of throwing information at problems.

Thus, the problem of bridging the gap between research and management can be perhaps resolved by reformulating the problem, so as to remove the notion that applying science involves rational information processing on the part of decision-makers (and therefore the requirement that scientific knowledge be successfully transferred to them). Hence, rather than asking why knowledge transfer efforts in the environmental field so often fall short of improving the adaptive capacity of institutions, the problem can be reframed from a complexity-based perspective to ask instead: “how can environmental scientists have greater influence on the emerging pattern of reality, such that human systems are more sustainably coupled with biophysical systems?” This shift in understanding is illustrated in Figure 7.1, which compares my original conceptual framework from Chapter 3 with this simplified complexity-based framework.

In the following sections I tentatively propose some complexity-based strategies for addressing this problem. I do so cautiously, and with some misgiving, as I believe there can be no prescriptive solutions when dealing with complex systems and wicked problems. As Richardson (2008) states, “Complexity ‘thinking’ is a particular attitude towards our ideas about the world and the world itself, not a particular tool/method, or even a particular language” (p.22). From his perspective, managers will gain more from understanding the philosophy of complexity, and the light it sheds on the limits of knowledge and how our underlying assumptions shape our worldviews and decisions (Richardson 2008).

7.6.1 Imagination: Coupling with the Future

“It is true, we shall be monsters, cut off from all the world; but on that account we shall be more attached to one another.”

—Mary Shelley, Frankenstein (1823)

As discussed in Section 7.4.2, the increasing complexity of global supply chains has ‘strung out’ the feedback links between industrialised societies and the biophysical systems that sustain them. It appears unlikely that engineered, information-based feedback loops, such as those applied in adaptive management, will be effective at shortening these attenuated linkages. Spatial shortening of these feedback loops will likely only occur ‘naturally’, in the event of a societal collapse that disorders global socio-economic governance patterns. In light of these difficulties, the other option is to try and establish longer-range temporal coupling with a desired future state.

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127 This brings us back to Godel’s theorems. Mathematics involves structuring fields of knowledge into deductive systems, which are intellectual constructs fully defined by the propositions put forth as the axioms of the field (2005). As such, the axiomatic systems referred to in Godel’s theorems are intellectual constructs that hamper full understanding of the object under study (Askanas 2006). Thus, the explanatory limits of an axiomatic system are an artefact of how we’ve constructed that axiomatic system, rather than being ‘real’ or ‘true’ limits. In other words, a set of axioms are incapable of formally proving some things which are evidently true about the system they describe; this paradox can only be resolved by resorting to non-formal metalanguage (Witzany 2011).

128 It should be noted that the structure of this question raises ethical concerns, as it is raised solely from the perspective of scientists’ values and interests versus those of society or an affected community. As outlined in Section 7.3.1, the Newtonian worldview held by most scientists is one whereby reductionist science is seen as objective and value-free, and scientific knowledge is seen as instrumental to increasing societal well-being. Scientific information is not, however, objective and value neutral (Foucault 1980), and scientists should be wary of privileging their values and preferences as surrogates for those of society as a whole (Lackey 2001). In order to avoid privileging certain systems of power over others (as exemplified by Figure 4.2), scientists need to acknowledge and accept influence from diverse other ‘ways of knowing’ (Meppem & Bourke 1999).

129 Ibid. 107, p.172.
Figure 7.1. A comparison between this study’s original conceptual framework (a) and a simplified complexity-based framework (b), which does not rely on knowledge transfer. In the new framework, research application is the direct result of engagement/interaction between scientists and stakeholders, rather than the indirect result of knowledge transfer and creating useful (i.e. salient, credible and legitimate) information. In (b) scientists improve their ‘creative capacity’ by directly interacting with parts of the decision-making system they hope to influence. In both frameworks knowledge brokers and boundary organisations can help catalyse relationships and overcome the barriers impeding engagement.
As detailed in Chapter 6, the future is imagination. In sharing our imaginations of the future, and therefore how we act into it, we co-create reality. On this basis, in order to influence emerging reality in a significant way, scientists have to participate in it, connect with others, and add their visions of a desired future (e.g. one with well-managed biophysical systems) to the collective’s imaginings. From the interactions that follow, new governing patterns might then emerge that somehow reflect their scientific visions.

This pertains to the words of Maturana and Varela (1992), who argue that the world that we see is “not the world but a world we bring forth with others” (p.245). Thus the “world will only be different if we live differently” (p.245). Likewise, Stacey et al. (2000) note that “people together shape what they perceive and hence the context in which they jointly act. They do so by pointing to this and inviting people to look at that” (p.177).

7.6.2 Creative Capacity vs. Adaptive Capacity

“People ask me to predict the future, when all I want to do is prevent it. Better yet, build it. Predicting the future is much too easy, anyway. You look at the people around you, the street you stand on, the visible air you breathe, and predict more of the same. To hell with more. I want better.”

—Ray Bradbury

This being the case, how then can scientists best share their imaginations so as to influence the emerging pattern of reality? As detailed in Chapter 6, we do not gather and process information about a pre-given reality, then make conscious decisions to better re-arrange it in our favour (i.e. to improve out adaptive capacity). Rather, we specify reality via coupling with other systems. Life constructs its own future. For humans, as for all other living organisms, the future is radically unpredictable. Through our own interactions we are co-creators of reality, neither engineers nor designers of it. As Rose (2003) states, we have the ability to construct our own futures, but not under circumstances which we choose. All we can do is add our voices and visions to the milieu, and hope to have influence. As Stacey (2001) argues, instead of trying to find ways of designing and managing whole systems, which no one individual or group can realistically control, the emphasis should instead be on paying attention to one’s own local participation.

As such, instead of focusing on devising rational objective arguments for others to use to re-arrange or design human systems—so as to improve the ‘adaptive capacity’ of these systems in relation to some external environment—environmental scientists should perhaps shift their focus to improving their own creative capacity. This means improving the impact of their own local participation in sharing their imaginings and therefore creating a reality, such that it is more sustainable. This requires that environmental scientists reframe their role of objective observer into that of active participator of. The following paragraphs outline a number of possible suggestions for improving the creative capacity of scientists and research programs.

7.6.2.1 Increase Number, Diversity & Intensity of Personal Interactions

Creative capacity refers the domain of possible futures a system can create. This is a function of the number and diversity of its connections between its agents and other systems (Kauffman 1993), and pertains to the quality and dynamics of human interaction in the present (Stacey 2001). Thus, environmental scientists can increase their creative capacity by expanding their domain of personal interactions. In this way, they are able to add their ‘biophysical rich’ imaginings of the future to that

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130 Quote sourced from Beley (2006).
131 Pielke (2007) suggests that scientists can become actively engaged in policy debates by taking on the roles of ‘issue advocate’ (taking a definite stand on an issue and preferred policies) or ‘honest broker’ (providing a wide range of policy options without advocating for any one of them), neither of which focus on sharing imagined futures. Pielke argues, however, that advocacy by scientists politicizes and damages the credibility of science. This stance is disputed by some critics (e.g. Howe 2007) who suggest scientific advocates are needed to balance the views of powerful interests and prejudices in policy debates.
132 For years, scientists have battled the Rosenthal Effect—the impact that the opinions, outlooks, theoretical and practical biases of researchers have been shown to have on performance of their subjects, be they rats or humans (Watzlawick et al. 2011). Scientists typically view observer bias as negative, and are always looking for ways of eliminating it. However, as quantum and chaos theory have shown us, this is a utopian ideal that can never be achieved. If environmental scientists reframed their understanding of observer bias from that of a problem to that of a potential advantage, they could potentially capitalise on the subjective influence research has on a system’s behaviour.
of others, and through dialogic interaction transform each other and the institutions they comprise (as per Healy 1997). New couplings between scientists and areas of the decision-making system can potentially interrupt habitual patterns of thinking and interacting. Scientists may want to be strategic in terms of assessing what scales and domains of governance they should be targeting for their interactions (e.g. Bodin & Prell 2011), based on the influence they are hoping to achieve. Direct personal coupling, resulting in sustained interaction, is more powerful than indirect means, such as by supplying people with information in the hope that it will convince them make a rational decision to change their existing behaviour pattern. Scientists can also be strategic in their interactions by paying attention to patterns of power relations and ideologies, who is talking/included and who is being silenced/excluded, how people manage their anxiety, and whether and how conversations are spontaneous and excited, or dull and repetitive (as per Stacey 2001). Research programs looking to have impact in a particular area can also use network analysis to identify ‘functional holes’ in their relationships with stakeholder groups and decision-makers, then strategically focus their efforts on bridging these gaps (Sandstrom 2011; Syme et al. 2012).

We must also recognise that scientific knowledge cannot be effectively disembodied from scientists and applied by others without significant diminishment of meaning, context and influence on decision-making and behaviour. Thinking otherwise is a relic of Taylor’s scientific management, and reliant on defunct information-processing views of cognition and decision-making. If science is to have greater influence, it has to be part of the decision-making system in terms of actively relating BODIES, not just reports. This premise is reflected in Bodin and Prell’s (2011) relational approach to resource governance, with its emphasis on social networks. It also relates to Funtowicz and Ravetz’s (1990, 1991, 1993) conception of publicly engaged post-normal science.

### 7.6.2.2 Engage in Everyday Conversation

Conversation is characterised by a creative and uninterrupted flow of cyclical stimulus-response between the parties involved, one that has an immediate effect on their patterns of interaction. Ordinary free-flowing conversation is how we share our imaginations and shape reality through our day-to-day interactions. People are more responsive to conversation than they are to the written word, and they are also more likely to respond to rhetoric-responsive conversation, the language of persuasion and imagination, than they are to passive and ‘rational’ representations of reality (see Donaldson 2005; Shotter 1994). As such, everyday conversation has more creative power than the representational-referential written communication typically applied by scientists in their efforts to be objective. This is the premise of Stacey’s (2001) complex responsive processes approach to organising.

By relegating their imaginings to passive paper abstractions, divorced from the creative power of day-to-day conversation, rhetoric and personal interaction, scientists limit themselves to a strategy of hope (as per Roux et al. 2006)—hoping that someone will seek out their paper imaginings, be persuaded by their rational arguments, and reengineer the system accordingly. Scientists wishing to have more influence can try to create space for having informal conversations with a diversity of people (as per Shaw 2002), particularly those within decision-making spheres they wish to influence. This may require a restructuring of job descriptions and resources within research institutions.

### 7.6.2.3 Seek Opportunity in Crisis

When adding their conversations to the milieu, scientists can also opportunistically and strategically look to interact with highly connected people who are operating in the areas of greatest connectivity and instability, i.e. where the action is. Unstable ‘zones’ near the edge of chaos, or near crisis, are where new voices are least likely to be subsumed by well-established governing patterns that are highly change resistant (Stacey 1996a). Thus, these parts of a system are where ideas have the best odds of being amplified and where transformational change is most likely to occur. Instabilities are also created when top managers are replaced in organisations (Nyström & Starbuck 1984). These occasions can also be turned into opportunities for creating new patterns of interaction between scientists and decision-making bodies. These ideas relate to the resilience literature, which identifies ecological crises (e.g. destructive wildfires, collapse of a fishery) as opportunities to build new and creative socio-ecological relationships (e.g. Gunderson 2003).
should be cautioned, however, that such strategies require tolerance for risk and uncertainty (as per Walters 1986), as the outcome of interactions with others, particularly in zones of instability, cannot be predicted and may not be as desired.

### 7.6.2.4 Use Narrative to Convey a Compelling Vision of the Possible

A number of authors have argued for using rich narrative approaches to understanding and resolving problems in complex socio-economic systems (e.g., Robertson et al. 2000; Tsoukas & Hatch 2001; Waltner-Toews et al. 2005). A narrative is an “account of events occurring over time” (Bruner 1991, p.6). According to Bruner (2009) narrative is used to give experience meaning—it is grounded in personal experience, contextual, and made effective by way of good story-telling. As such, it typically used to create a gripping account of past events that conveys a particular worldview of ‘what is’ and why it is so. For example, Meppem and Bourke (1999) illustrate how the sustainability debate is shaped by contesting narratives jostling for rhetorical dominance, each one disputing the others’ ‘truth claims’, which Bourke and Meppem (2000) describe as valorised expressions of conflicting values.

In Chapter 6, we saw that capturing people’s imaginations requires a vision for the future. This involves persuasion by telling captivating stories about a possible future that excites the imagination, rather than by way of argument through analysis or representation. Using narrative modes of discourse to paint a compelling vision of the future as well as to rationalise the past (surfacing and sharing multiple narratives of the past being an important step in revealing underlying motivations and assumptions of different stakeholder groups and building mutual understanding and trust between them) may help scientists and/or research programs shift people’s attention away from intractable and polarising debates around what is true, and towards more creative and perhaps constructive dialogue around what is possible.

### 7.6.2.5 Participate in Collaborative Planning

Scientists can also enhance their creative capacity in more formal ways, by participating in collaborative planning processes. Collaborative (or communicative) planning focuses on facilitating communicative interaction between stakeholders, deliberating about collective futures, and fostering community empowerment (Huxley & Yiftachel 2000). As such, it presents scientists with opportunities to interact and build relationships with a diversity of stakeholders, and to share their visions for the future. Because collaborative planning is transdisciplinary, it allows participants—including scientists—to collectively explore a much larger phase space than would be available to them on own, thereby radically expanding the domain and complexity of interactions

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133 Bruner (2009) argues that there are two complementary and irreducible forms of cognitive functioning or thought: logico-scientific and narrative. These two forms differ radically in terms of how they are verified and what they convince of. Logico-scientific thought is verified by logic and empirical proof, and aims to convince others of ‘truth’ about reality by way of a good argument. Narrative, on the other hand, is verified by its ‘lifelikeness’, and convinces others of verisimilitude (truthlikeness) by way of a good or inspiring story. The narrative mode involves imaginative application, “good stories, gripping drama, believable (though not necessarily ‘true’) historical accounts. It deals with human or human-like intention and the vicissitudes and consequences that mark their course” (p.13). The logico-scientific mode by comparison, is “heartless” in its logic. It seeks to transcend “the particular” through higher and higher abstraction, and “washes stories away when causes can be substituted for them” (p.13).

134 Bourke & Meppem (2000) argue that averting ecological crisis requires instigating social processes that encourage stakeholders to resist the distortions of political narratives upholding the status quo.

135 This does not discount the need for or importance of scientific analysis; rather it recognises that scientific analysis, on its own, is unlikely to solve complex socio-ecological problems, and often has limited persuasiveness. Scientists may have more influence on reality-shaping dialogue by sharing (and thereby likely also transforming) their imaginative visions (based on conclusions, values, and aspirations drawn from scientific analysis), than by making analytical arguments.

136 As per Bourke & Meppem (2000).


138 Collaborative/discursive planning focuses on using creative dialogue to build trust, relationships and mutual understanding among participants, with the aim of inspiring joint action. More conventional stakeholder planning processes involve negotiation and analytic problem-solving through discussion, with participants focused on presenting and defending their positions with the aim of ‘winning’ (see Section 6.3.9.1 for a comparison between dialogue and discussion). Meppem (2000) advocates the discursive community as a genuinely collaborative process, one which is based on learning and the application of transdisciplinarity and methodological pluralism. According to Meppem (2000) the strength of discursive communities lies in their capacity for “establishing relational connections” (p.54).
they can enter into and the possible futures they can co-create.

Because collaborative planning increases connectivity\(^\text{139}\) (in terms of number and diversity of connections) between actors in a socio-ecological system, it also has transformative potential—the potential to spontaneously generate new patterns of interaction between its participants (as per Stacey 1996a). This in turn presents opportunities for transcending wicked problems caused by polarised views and entrenched patterns of interaction between system agents. This relates to Meppem and Bourke’s (1999) “idea that a worldview constructed and reinforced within the bounds of a self-referential discipline limits the potential for creative stimulation and consequent effective action.” It is likewise noted by Meppem and Gill (1998) who state: “The conventional stranglehold of disciplinary thinking in policy circles limits the capacity of our decision makers to unravel the complexity of all real world environmental policy and management problems,” (p.121).

Research programs seeking to improve their research impact and contribute to resolution of complex resource management issues can also benefit from integrating their activities—ideally from design to implementation—with collaborative planning processes. However, as noted by Schusler et al. (2003), without the commitment of institutional, financial and human resources for sustained and ongoing collaboration (5 to 10+ years according to Roux et al. 2006), deliberative processes are unlikely to result in action on the ground.

7.6.2.6 Foster Creative Dialogue

As we saw in Chapter 6, one cannot understand a system whole through analytic processes (i.e. looking at the parts) alone, and attempting to do so will likely reinforce the existing pattern of the system, despite intentions to the contrary\(^\text{140}\). We can never be certain whether our analytically applied scientific knowledge will help resolve our sustainability issues or create more of what we don’t want. Creative, non-reductionist processes are more likely trigger insight into higher order patterns that are maintaining a problem situation, and present novel, qualitatively different solutions for transforming these patterns (i.e. transforming the system attractor).

Insight is a right-hemisphere process that cannot occur when the left-brain is engaged in analysis. It is, however, often preceded by a period of sustained and frustrated problem analysis. Analysis involves discussion, whereas creativity involves dialogue, as per Table 6.2. Hence, when our analytic and/or defensive thinking and conversation is suspended and shifts instead to a more creative and non-judgemental mode, the potential for transformational change in the system increases. Informal and engaging group processes are more creative than formal analytical discussions. As such, when interacting and collaborating with others, scientists and research programs may want to consider dedicating time and resources to fostering creative dialogue, rather than just discussion. For example, Meppem and Bourke (1999) advocate communicative approaches to developing environmental policy via reflective processes in discursive communities. This relates to Funtowicz and Ravetz’s (1993) notion of scientific argument as interactive dialogue rather than formalised deduction. Tackling such approaches may require coaching on suspending judgement, turning discussion into dialogue, and conflict mediation.

Through creative dialogue we can also focus our attention on our imaginations and visions for the future, rather than on devising paper plans for a future based on an analysis of what went wrong in the past—with all the defensiveness and pattern reinforcement that involves. From imagination, action follows. Analytically derived plans are abstractions cut off from the life-giving patterns of relationship they represent. As such they are ‘dead things’ that are unlikely, on their own, to generate substantive action. However, if one does manage to breathe life into them, they may unexpectedly turn into ‘monsters’, and reap perverse results (as per Stacey et al. 2000).

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\(^{139}\)Nudging it closer to the edge of chaos, as per (Kauffman 1993).

\(^{140}\)As per Watzlawick et al. (2011), who argue that attempting to change complex systems by applying first order (analytic) solutions typically reinforces or escalates the problem at hand, generating dead locks, games without end, and vicious circles (see Appendix 4, Section A4.4.3).
7.6.2.7 Use Modelling to Catalyse Dialogue and Extend Imagination

If properly wielded, computer models and role-playing games, such as those applied by D’Aquino et al. (2003), can potentially be used as extensions of people’s imaginations and catalysts for creative dialogue. This requires that modelling projects be designed and facilitated with the explicit intention of fostering ongoing creative interaction between participants, rather than generating ‘accurate’ depictions of reality. However, as is the case with other forms of deliberation (as noted above by Schusler et al. 2003), without the commitment of sufficient time and resources for ongoing collaboration, participatory modelling projects are unlikely sustain joint action.

7.6.2.8 Enlist Knowledge Brokers or Boundary Organisations

Realistically, many scientists will lack the time, aptitude, skills and/or willingness to deploy the strategies outlined above. Knowledge brokers possessing the appropriate skills and attributes (Box 3.1) can be employed to facilitate these strategies within the framework of a research program and/or collaborative planning process, by helping scientists communicate better with non-scientists, catalysing and mediating relationships between different individuals and groups at appropriate scales of governance, and identifying opportunities for applying science, as per the suite of knowledge brokering strategies outlined by Michaels (2009) in Table 3.4.

Alternatively, research programs can adjust their hiring and promotion criteria to select for science leaders with good knowledge brokering skills, and build knowledge brokering into their job descriptions and budgets accordingly. In so doing, these leaders can represent the interests and work of other scientists who prefer to be ‘left at the workbench’, and also take on the responsibility (and risk) of interacting with higher-power stakeholders or in high-stake political arenas. Boundary organisations can serve a similar function to knowledge brokers on a larger scale; however, the one-on-one personal aspect of knowledge brokering makes it particularly suitable for the purposes outlined above.

7.6.2.9 Change Metrics and Incentives

Improving the creative capacity of scientists also requires moving away from incentives and evaluations that primarily measure outputs (reports, publications, etc.) or changes in levels of representative knowledge among target end-users of research. Instead, new metrics need to be developed which reflect the scope and quality of interactions scientists/research programs have with other parts of the socio-ecological system (particularly decision-makers and decision-making processes), and any qualitatively new patterns of interaction/behaviour that emerge through their relating. Meppem and Gill (1998), for instance, suggest key measures of success for sustainability planning should focus on context-related processes, such as the maintenance of creative learning frameworks. They also argue that stakeholders should be part of the science evaluation process, as is likewise contended by Funtowicz and Ravetz (1990, 1991, 1993) in their notion of extended peer communities.

7.7 Further research needs

This study was primarily theoretical in nature, and the supporting empirical results from the action research study are tentative, due to the small sample size of evaluation interviews. In addition, from a complexity-based perspective, the study was designed to test primarily for the wrong outcomes. As such, more robust investigations, in terms of design and sample size, are needed to empirically test this study’s proposed complexity-based conceptual framework. In addition, further research is needed to test the suggested methods for increasing ‘creative capacity’, to assess if and how they affect environmental scientists’ influence on emerging patterns of reality (such that human systems are more sustainably coupled with biophysical systems), and to assess whether they prove more successful than conventional knowledge transfer mechanisms.

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7.8 Conclusion

“If you want to build a ship, don’t herd people together to collect wood and don’t assign them tasks and work, but rather teach them to long for the endless immensity of the sea.”
—Antoine de St. Exupery

The purpose of this study as outlined at its outset was to shed light on why knowledge transfer efforts in environmental management so often fall short. In keeping with Watzlawick et al.’s (2011) principles of problem formulation, instead of entering into detailed problem analysis as to why knowledge transfer efforts in Ningaloo had a limited effect, I embarked on a deep investigation of the assumptions underlying the problem statement itself.

Through this investigation the workings of our old Newtonian paradigm were surfaced, and I was able to synthesise an alternative ontology based on 20th century insights derived from the quantum and complexity sciences, and process philosophy. In applying this ontology, the errors in logical typing wrought by our Newtonian beliefs and assumptions were revealed, together with their paradoxical consequences. In particular, it showed how an error in problem formulation has led to a vicious circle whereby our efforts to solve the problem of knowledge transfer may be creating the problem we are using knowledge transfer to try and solve.

Shotter (1994) argues that such entrapments are not caused by the true nature of ourselves or reality, but rather by the literary and textual ways we have formulated our problems, so as to uphold our habitual ways of thinking. In so being, we are not absolutely resigned to the perpetuity of our wicked141 problems, as they are cages of our own thinking, supposed realities we have talked ourselves into through our conversations (Shotter 1994).

Instead, we can study how we became entrapped in the first place, as did I in this investigation. Or more importantly, we can take our focus away from producing ‘things’ and redesigning our human systems to improve their ‘adaptive capacity’, and shift it toward improving our own creative capacity instead—by building relationships, changing our conversations, and expanding our day-to-day personal interactions with others. And in both our dealings with others and in our imaginations, we can momentarily suspend our judgement and let go of our strongest beliefs. Then, in the words of Donella Meadows, by “profoundly, madly, letting go” (1999, p.19) we open ourselves to an unmediated experience of the present moment, and the insight and creative imaginings that affords. And in turning our gaze outward, we leave the rarefied world of abstraction, and actively join the rabble in the messy and unpredictable process of co-creating reality, with all the tension, conflict, cooperation and uncertainty that entails.

141 Ibid. 107, p.171.
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APPENDIX 1

HISTORICAL AND PHILOSOPHICAL CONTEXT: STEPPING BACK FROM THE PROBLEM
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**HISTORICAL AND PHILOSOPHICAL CONTEXT: STEPPING BACK FROM THE PROBLEM**

“What is your aim in philosophy? —to show the fly the way out of the fly-bottle”

—Wittgenstein

### A1.1 Introduction

A basic function of philosophy is to examine the assumptions that underlie our thinking (Heylighen et al. 2007). Metaphysics\(^1\) is a branch of philosophy that concerns itself with investigating the nature of reality and what is ultimately ‘real’ (Craig 1998). The central branch of metaphysics is ontology\(^2\), which examines questions of ‘being’ (i.e. existence) and what types of things exist (Craig 1998)—i.e. what reality consists of. Epistemology is a branch of philosophy that “investigates how we can know and reason about that reality” (Heylighen et al. 2007); it asks what is knowledge, how is it acquired, and to what extent can a thing or a phenomena be known? Lorimar points out that despite modern science having evolved from a series of centuries old metaphysical and epistemological assumptions, today’s scientists rarely concern themselves with epistemology or metaphysics, quoting Willis Harman (1994) who said “Epistemology is to scientists what ornithology is to birds!” However, failure to recognize the core assumptions that frame how they think about the world renders scientists (and society in general) vulnerable to committing fundamental errors when attempting to formulate and resolve today’s intractable and ‘wicked’ problems, errors which can lead to vicious circles and exacerbation of the very problems we are trying to solve (Bateson 2000; Watzlawick et al. 2011).

The importance of becoming aware of the assumptions that govern our behaviour is highlighted by an example from mathematical game theory showing that “if a person comes to ‘know’ a theory about his behaviour, he is no longer bound by it but becomes free to disobey it” (Howard 2003, p.xx). Without such awareness our problem-solving abilities are caged by the paradigms within which we currently operate (see Kuhn 1962; Shotter 1994) similar to the two dimensional creatures inhabiting Abbott’s (2011) satirical Flatland, who, even when confronted by an actual three-dimensional being (empirical proof!), cannot comprehend the notion of three-dimensional space. This is because their thinking is confined by an unassailable belief that the world is made up of only two dimensions (based on the collective weight of their past empirical observations). In the words of Einstein, “Science without epistemology is—in so far as it is thinkable at all—primitive and muddled.” (Pais 1982, p.13). The wisdom of being sceptical of underlying assumptions was embodied in the brilliant mathematician Henri Poincare, who, rather than working from pre-established principles, as do most mathematicians, started from scratch in all his work (O’Connor & Roberston 2003).

The purpose of this appendix is to present a simplified overview of selected topics in the history of Western philosophy, science, and mathematics. This will provide a historical context of how the schools thought relevant to this study evolved up to the post-war period. Drawing largely on the work of Capra (1997, 2010) and Heylighen et al. (2007), the discussion will also reveal the shifting nature of the schools’ underpinning assumptions, and how they have mutually shaped each other since the times of the ancient Greeks.

Definitions for key philosophical terms used in the following account are outlined below.

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1. Van Inwagen (2007) notes that metaphysics is “notoriously hard to define”—its definition has shifted over time and is the source of much scholarly contention.
2. In the 17th century, as the term ‘ontology’ came into use, metaphysics became something of a ‘catch-all’ category; Wolff responded by breaking metaphysics down into ‘general metaphysics’—the study of being as such, or ‘ontology’, and ‘special metaphysics’—the study of particular types of being, e.g. material, spiritual, etc. (van Inwagen 2007). Since then metaphysics has often viewed as synonymous with ontology. The Routledge Volume of Science, Logic and Mathematics in the 20th Century states “the relation between METAPHYSICS and ontology is unclear...simply put ‘ontological’ means ‘having to do with existence’” (Shanker 1996).
Appendix 1

Philosophy, (1) the critical examination of the grounds for fundamental beliefs and an analysis of the basic concepts employed in the expression of such beliefs.* 2) Careful thought about the fundamental nature of the world, the grounds for human knowledge, and the evaluation of human conduct. As an academic discipline, philosophy's chief branches include logic, metaphysics, epistemology, and ethics.**

Metaphysics, (1) the philosophical study whose object is to determine the real nature of things—to determine the meaning, structure, and principles of whatever is insofar as it is.* 2) Branch of philosophy concerned with providing a comprehensive account of the most general features of reality as a whole; the study of being as such. Questions about the existence and nature of minds, bodies, god, space, time, causality, unity, identity, and the world are all metaphysical issues.**

Ontology, (1) the philosophical study of being in general, or of what applies neutrally to everything that is real*. (2) Ontology is concerned with identifying, in the most general terms, the kinds of things that actually exist.**

Epistemology, the study of the nature, origin, and limits of human knowledge. The field is sometimes referred to as the theory of knowledge.*

Logic, the study of the nature and types of logic, including problems in the field and the relation of logic to mathematics and other disciplines.*

Ethics, also called moral philosophy, the discipline concerned with what is morally good and bad, right and wrong.*

Materialism, (1) also called physicalism, the view that all facts (including facts about the human mind and will and the course of human history) are causally dependent upon physical processes, or even reducible to them.* (2) Belief that only physical things truly exist. Materialists claim (or promise) to explain every apparent instance of a mental phenomenon as a feature of some physical object.**

Idealism, (1) any view that stresses the central role of the ideal or the spiritual in the interpretation of experience. It may hold that the world or reality exists essentially as spirit or consciousness, that abstractions and laws are more fundamental in reality than sensory things, or, at least, that whatever exists is known in dimensions that are chiefly mental—through and as ideas.* (2) Belief that only mental entities are real, so that physical things exist only in the sense that they are perceived.**

Dualism, (1) any theory that mind and body are distinct kinds of substances or natures. This position implies that mind and body not only differ in meaning but also refer to different kinds of entities. Thus, a dualist would oppose any theory that identifies mind with the brain, conceived as a physical mechanism.* (2) Belief that mental things and physical things are fundamentally distinct kinds of entities.**

Panpsychism, a belief that everything in the world has some mental aspect. This view attributes some degree of consciousness—however small—even to apparently inert bits of matter.**

A priori, (1) knowledge that is independent of all particular experiences, as opposed to a posteriori knowledge, which derives from experience.* (2) An a priori argument, then, is taken to reason deductively from abstract general premises. The truth of the argument can be determined by reason alone, e.g. 3+4=7.**

A posteriori, (1) knowledge derived from experience, as opposed to a priori knowledge.* (2) An a posteriori argument relies upon specific information derived from sense perception. The truth of the argument can be discovered only by reference to some matter of fact, e.g. Chicago is on the shore of Lake Michigan.**

Rationalism, (1) the view that regards reason as the chief source and test of knowledge. Holding that reality itself has an inherently logical structure, the rationalist asserts that a class of truths exists
that the intellect can grasp directly.* (2) Reliance on reason as the only reliable source of human knowledge; the epistemological theory that significant knowledge of the world can best be achieved by a priori means.**

**Empiricism,** (1) the view that all concepts originate in experience, that all concepts are about or applicable to things that can be experienced, or that all rationally acceptable beliefs or propositions are justifiable or knowable only through experience.* (2) Reliance on experience as the source of ideas and knowledge; the epistemological theory that genuine information about the world must be acquired by a posteriori means, so that nothing can be thought without first being sensed.**

**Positivism,** (1) any system that confines itself to the data of experience and excludes a priori or metaphysical speculations.* (2) Belief that natural science, based on observation, comprises the whole of human knowledge.**

The four causes, Aristotle's four answers to the question of why something is:

**Material cause,** (1) that of which and out of which a thing is made.* (2) The stuff from which the thing is made.**

**Formal cause,** (1) the form or pattern of a thing, which may be expressed in its definition.* (2) The pattern or structure the thing has.**

**Efficient cause,** (1) origin of a change or state of rest in something, e.g. a sculptor carving a statue. (2) The agent that imposed this form on that matter.**

**Final cause,** (1) the end or goal of a thing—that for the sake of which a thing is done.* (2) The purpose for the thing.**

**Determinism,** theory that all events, including moral choices, are completely determined by previously existing causes (i.e. efficient causes). Determinism is usually understood to preclude free will because it entails that humans cannot act otherwise than they do. The theory holds that the universe is utterly rational because complete knowledge of any given situation assures that unerring knowledge of its future is also possible.*

**Teleology,** explanation by reference to some purpose or end; also described as final causality, in contrast with explanation by efficient causes only.*

**Reductionism,** a view that asserts that entities of a given kind are collections or combinations of entities of a simpler or more basic kind or that expressions denoting such entities are definable in terms of expressions denoting the more basic entities. Thus, the ideas that physical bodies are collections of atoms or that thoughts are combinations of sense impressions are forms of reductionism.*

**Atomism,** any doctrine that explains complex phenomena in terms of aggregates of fixed particles or units.*

* Source: *Encyclopedia Britannica* (http://www.britannica.com)
** Source: Philosophy Pages from Garth Kemerling (http://www.philosophypages.com/index.htm)

### A1.2 Ancient Era & Middle Ages

#### A1.2.1 Unity of Opposites and Flow of Becoming

Citing Hesiod's *Theogony,* the Chinese notion of yin and yang, Babylonian creation stories, and the terrible cross roads occupied by the Indian creator god Shiva, Briggs and Peat (1989) argue that ancient peoples' world view was that of a universe held together by an uneasy tension and reciprocity between order and chaos, with chaos being “something immense and creative” (p19).
The Pythagoreans of the 5th century BC, for example, believed in a limitless void that, mathematically speaking, “distinguishes the natures of things, since it is the thing that separates and distinguishes the successive terms in a series” (Kirk & Raven 1983, p.340), as in the case of numbers. They extrapolated this to an understanding that the universe is a “living whole of different interconnected parts separated by ‘void’ between them” (York 2013). Thus, both the continuum of numbers and the cosmos are a “play of emptiness and form” (York 2013), of the limiters and unlimiteds, which, when locked together by harmony, result in an ordered universe (Kirk et al. 1983).

The Pythagorean notion that things are thrust into existence by the co-existence of their opposite ‘nothing’, without which they could not be distinguished, is related to the ideas of the pre-Socratic philosopher Heraclitus. Heraclitus is noted for his teachings on the ‘unity of opposites’, which argue that all existing entities consist of pairs of contrary properties; it is through this opposition that they come into being (Graham 2011). According to Heraclitus, opposites, though different, are nonetheless interconnected. For example, sleeping and waking are contrary properties that are connected, as one changes around to the other (Graham 2011); indeed, neither concept could exist without the other. This also echoes Heraclitus’ notion of collections: “Collections: wholes and not wholes; brought together, pulled apart; sung in unison, sung in conflict; from all things one and from one all things” (Graham 2011).

The ancient Pythagoreans were also focused on patterns in reality. They distinguished pattern from matter, or substance; pattern being that which gives substance its shape (Capra 1997). Bateson (2000) notes that Pythagoreans were more interested in patterns than substance, stating that their arguments were basically: “Do you ask what it is made of—earth, fire, water, etc.? Or do you ask, ‘What is its pattern?’” (p.455). Heraclitus is also notable for his belief that reality (i.e. the universe) is in continuous flux, and that all things flow, using the metaphor that one can never step into the same river twice. As such, his philosophy focused on the never-ending process of ‘becoming’ rather than on ‘being’ (Graham 2012); it was a philosophy of change and process rather than substance.

A1.2.1 Atomism & Determinism

Parmenides, however, challenged Heraclitus’ and Pythagorean notions of change, as well as the notion of ‘void’, or nothingness, arguing that there is no such state as ‘non-being’. Instead, he believed that all of reality is comprised of a single, indivisible mass, and that change and motion are illusory, there being no void to move into (Berryman 2011). Thus, there is only ‘being’, one kind of thing (Silverman 2008).

In an attempt to reconcile the differences between Heraclitus’ ever-changing reality and Parmenides’ unchanging, singular reality, fifth century BC Greek philosophers Leucippus and Democritus proposed their materialist theory of atomism (Berryman 2011). Atomism posits that all entities are comprised of small indivisible particles known as atoms, separated by an infinite void within which they move around (equating atoms to multiple unchanging Parmenidian entities floating around in a void). Shifting configurations of atoms constitute the changing shapes of objects, and also generate the sensations felt by organisms (Berryman 2011). In this view, reality is both unchanging (in the form of irreducible atoms), and always changing (in the form of shifting configurations of atoms). The Atomists were mechanistic and deterministic in their belief that the world had no purpose, divine intervention or final cause. They believed that all phenomena (i.e. compositions of atoms) could be understood exploring the prior circumstances that caused the event (i.e. the prior interactions that caused a particular atomic configuration to materialise) (Berryman 2011). This is consistent with Aristotle’s notion of ‘material’ and ‘efficient’ causes, as discussed below.

A1.2.2 Plato and Aristotle

With the coming of the Socratic era (400-300 BC), notions of an ever-changing universe, continuously brought into being by the interplay of chaos and order, something-ness and nothingness, further gave way to a focus on ordered aspects of the universe and the nature of
‘being’ and ‘things’, rather than the process of ‘becoming’ (Briggs & Peat 1989). Plato argued against atomism, stating that the beauty of the world couldn’t possibly result from mechanistic collisions of atoms (Mastin 2008). Aristotle, Plato’s pupil, viewed matter as being continuous, and rejected the notion of ‘void’ held by the atomists as being in violation of physical principles (Mastin 2008). Plato and Aristotle also disputed Democritus’ reduction of all things to material and efficient causes, in that they believed the universe had a purpose, or a ‘final cause’, that enquires about the world should prioritise teleological investigation into what purpose a phenomena serves (Falcon 2012). As such, even after being taken up by the Epicureans in 300-200BC (Berryman 2011), the atomistic view of reality fell away in favour of the Aristotelian, disappearing from view until resurrected hundreds of years later by 17th century Renaissance thinkers such as Gassendi, Galileo, and Boyle (Chalmers 2010).

Socratic philosophers were very much concerned with the role of matter and form in comprising reality. Individual things were seen to have properties, such as colour, size, shape, location etc. Plato is considered one of the early exponents of idealism in that he believed that the properties of things exist independently of those things, as abstract, eternal forms or ideas, created by an intelligent designer in a realm beyond space and time (Mcintosh 2011). As such, all things in the world unfold in accordance to these ideal forms. Because he also held the materialist notion that matter is real, Plato is regarded as a dualist (Robinson 2011). Aristotle, on the other hand, disagreed with Plato’s idea of an abstract, intelligently designed world of forms, believing instead that properties dwelled within material things as innate qualities (Cohen 2009). He believed that forms cannot exist separately to substance. According to Aristotle, these indwelling properties are in essence final causes, and all things in the world unfold in accordance with their ‘internal natures’ (e.g. a seed has a tree as its final cause, therefore it becomes a tree) (Cohen 2009). Metaphysically, Aristotle is said to vacillate between idealism and dualism (Ballantyne 2008).

In terms of epistemology, Aristotle was both an empiricist, in that he believed that experience was the best means of knowing efficient and material causes, but also an idealist in that he believed intuition and reason were needed to gain true knowledge about the ‘essence’ of things (Pajares 2012). Aristotle viewed the world as an ordered place, with all beings ordered in increasingly complex hierarchies, and believed in the human capacity to understand such order (2013). Capra (1997) argues that Aristotle’s philosophy and science later went on to dominate Western thinking for two thousand years, with an authority that was almost as unquestioned as that of the church.

A1.2.3 Ptolemy & Geocentrism

While some Greek thinkers, such as Aristarchus, believed the earth revolved around the sun, Aristotle postulated that the earth was the centre of the universe, and that celestial bodies, including the sun, moved in perfect circles around it (Rabin 2010). However, actual observations of planetary movements did not conform with Aristotle’s cosmology, primarily because the outer planets appeared to move backward in a retrograde motion before moving forward again (Rabin 2010). In the second century BC, Ptolemy reconciled these observations with Aristotle’s geocentric universe by developing the idea that the planets traced epicycles while orbiting the earth. His convoluted system of epicycles enabled close approximate predictions of planetary movements whilst maintaining the earth at the centre of solar system (Rabin 2010). This geocentric view of the cosmos was maintained as an article of faith in medieval Europe, and was largely unchallenged for the next 1600 years.

A1.2.4 Scholasticism

After the collapse of the Greek-Roman empires, western civilisation descended into the anarchy and turmoil of the Dark Ages. However in the 12th century, the work of ancient Greek philosophers was rediscovered and resurrected by medieval universities. Efforts by medieval ‘schoolmen’ to reconcile Greek philosophy, primarily that of Aristotle, with Christian theology led to the emergence of Scholasticism (Tamayao 2012). Scholasticism became the dominant philosophy of the Middle Ages, reigning in Western universities from 1100 to 1500. The Scholastics revered reason, and as such scholasticism is more a method of critical thought than a philosophy. They worked to synthesise Greek logic, science, pagan philosophy and Christian theology, with a focus
on Socratic dialectical reasoning \(^3\) (Tamayao 2012). Arguments around faith versus reason and the existence of God characterise scholastic debate. Notable scholastic thinkers include Thomas Aquinas and William Ockham.

### A1.2.5 Copernicus & Heliocentrism

In the early 1500s, the Polish polymath Nicolaus Copernicus devised a heliocentric (sun-centred) system by which planetary motions could be explained. Copernicus’ theory explained retrograde motions without using Ptolemy’s epicycles, and satisfied celestial observations with fewer explanations (Rabin 2010). Although fearful of how his controversial ideas would be received, Copernicus eventually published his theory, initiating the Scientific Revolution and blowing his society open by placing man outside the centre of the universe (Kauffman 1995).

### A1.3 Scientific Revolution

#### A1.3.1 Empiricism & Cartesian Reductionism

The next major shift in Western thought occurred during the scientific revolution (i.e. early modern period) in the 17th and 18th century. This period saw the rise in empiricism (the belief that knowledge is primarily derived from the senses and experience) in the works of Bacon, Locke and Hume, after Galileo removed quality from science and restricted it to phenomena that could be measured and quantified (Rogers 2004; Sheldrake 1994). This in turn led to the formulation of the scientific method and Comte’s doctrine of positivism. Positivism contends that empirical science (i.e. a posteriori) is the best approach for explaining how the world works (Bourdeau 2011). Empiricism presented a challenge to the dominant rationalist and idealist epistemologies of the time, which deemed the human senses unreliable, and privileged (a priori) thought, intuition and reason over observation (Prinz 2006). Using telescopic observations, Galileo found and published empirical evidence supporting and fine-tuning Copernicus’ heliocentric celestial system; for his effort he was deemed a heretic and imprisoned for the remainder of his life\(^4\) (Rogers 2004).

Rene Descartes unified algebra and geometry to invent analytical geometry and Cartesian coordinates. He also devised a revolutionary concept of analytic thinking called reductionism. Reductionism is premised on the idea that to understand a complex phenomenon, you simply have to pull it apart and analyse its component parts (Heylighen et al. 2007). Descartes’ formulation of reductionism coincided with the invention of the clock, and his reductionist worldview is widely compared to that of a clockwork universe (Heylighen et al. 2007). Descartes did not believe in the ‘void’ and as such, held that all phenomena could be infinitely subdivided, there being no elementary particles, as believed by the ancient Atomists (Hatfield 2008). He also did not believe in final causes; rather he believed that all phenomena came into being mechanistically by cause and effect, though subject to nature’s basic and immutable mathematical laws that themselves are determined by God (efficient causes, upward causation) (Psillos 2004). This implied a mechanical and divinely-determined universe (Bertrand 2010).

#### A1.3.2 Cartesian Dualism

While Descartes viewed the universe, animals and the human body as complicated clockwork machines (Capra 1997), this view conflicted with prevailing religious notions of humans having free will over their actions (Heylighen et al. 2007). As such, Descartes proposed a dualist philosophy of mind and matter to resolve the contradiction, proposing that the human mind is of a different category of substance than that of the body, and therefore not subject to deterministic laws (Heylighen et al. 2007). Thus, the mind was the ‘ghost in the machine’, so to speak (Robinson 2011). This created philosophy’s tenacious ‘mind-body’ problem, which continues to create debate to this day (Hatfield 2008). Descartes’ dualist notion of reality was then countered by ‘monist’

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\(^3\)The Socratic dialectic is a method of resolving argument through a process of presenting arguments (theses) and counter-arguments (antitheses), leading to a synthesis of the two arguments, or some form of improvement in the argument (Cirne-Lima 1997).

\(^4\)The Pope deemed Galileo a heretic for refuting the notion that the earth was the centre of the universe and demanded a retraction. After later publishing a defence of the Copernican system, Galileo was tried and convicted, and spent the remainder of his life under house arrest.
Appendix 1

philosophers contending that reality consists of just one substance: either just mind or just matter. This heralded philosophy’s modern materialist-idealist split, with materialists contending that mind and matter are in fact both matter (e.g. Hobbes), and idealists contending that mind and matter are both products of the mind (e.g. Berkeley) (deVries 2004; Mastin 2008).

A1.3.3 Revival of Atomism

Although rejected by Descartes, the ancient metaphysics of Atomism were revived by other 17th and 18th century thinkers, such as Galileo, Gassendi, Cordemoy, Bacon, Hobbes and Newton, who believed in the existence of elementary particles, and who argued that Descartes’ view would mean there is no corporeal substance to the universe (Chalmers 2010; Smith 2010). In this atomistic and material worldview, material phenomena arise as a consequence of different spatial configurations of atoms. These thinkers did not believe in Plato and Aristotle’s final causes; instead, they adopted the ancient atomistic view of a deterministic universe, shaped through cause and effect (efficient and material causes), albeit one whereby particles and the forces between them are created by God (Capra 2010).

A1.3.4 Newton’s Classical Mechanics

In 1687 Isaac Newton, schooled in the works of Descartes, Copernicus and Kepler, laid the foundation of classical (or Newtonian) mechanics, with his laws of motion and theory of universal gravity (Smith 2007). Newton introduced the concept of absolute space and time, whereby space and time are regarded as real and independent aspects of reality (Rynasiewicz 2004). In Newton’s view, time exists independent of the observer and proceeds at its own pace through the universe. Likewise, space is also external and independent of observation. Thus, in classical mechanics, change is simply a spatial rearrangement of material components set against (and independent of) the backdrop of absolute space and time, their movement governed by deterministic laws of cause and effect (i.e. upward causation) (Rynasiewicz 2004). By knowing the initial positions and velocities of particles or components that make up a system, in theory you can, given enough computational power, predict exactly where a system will be in a given moment in time (i.e. you can predict the system’s evolution) (Capra 2010; Heylighen et al. 2007). In theory, one can also reverse the sequence of events to deduce exactly where a system was at given moment in the past (i.e. the so-called ‘the arrow of time’ is theoretically reversible in deterministic systems) (Heylighen et al. 2007; Prigogine & Stengers 1984). Like Descartes’ clockwork universe, the linearity of Newton’s theories reflects a mechanistic conception of a simple, predictable cosmos (Capra 2010).

Newton’s absolutist theory of space and time was a matter of much controversy among relationists of the time, notably Leibniz, who argued that space made no sense except when viewed in the relative location of two bodies, and time made no sense except in relation to the movement of bodies (Ferraro 2007). This controversy died away with the success of Newton’s ideas until it resurfaced in the 19th century (Ferraro 2007).

A1.3.5 Newton’s Differential Equations

Prior to Newton, mathematicians were plagued by their inability to devise an equation whereby the exact speed of an accelerating or decelerating body could be determined at a given time (Capra 1997). Newton revolutionized mathematics by devising differential calculus as a means of solving the problem (Capra 1997). Newton’s laws of motion and gravitation are based on linear differential equations (equations having solutions which can be added together to create new solutions). Linear equations do not incorporate feedback, meaning A may cause B, but B has no effect on A. In such equations, small changes cause small effects, and large changes either cause large effects or effects that can be explained by summing up many small changes; in addition, solutions for one equation can be generalized to others (Briggs & Peat 1989, p.23). For example, using Newton’s law of universal gravitation, total gravitational force can be calculated by adding up the gravitational forces contributed by different masses. From Newton’s equations the basic properties of the solar system

5 From antiquity, time and space had both been regarded as relative, abstract concepts, with space a measurement of the relative arrangements of different material bodies, and time a measure of the relative cycles of change, or motion (Rynasiewicz, 2004).
could now be predicted (Capra 1997). Other scientists quickly came to rely on Newton’s differential equations to explain a wide variety of phenomena, including plant growth, the motion of fluids, and burning coal (Briggs & Peat 1989).

**A1.3.6 Materialism & Determinism**

The Cartesian and Newtonian ontology of the universe can be summed up as one of materialism and determinism. Materialism dictates that reality (including all phenomena, physical, biological, mental and social) ultimately consists of matter. Consciousness, life, organisation and purpose are reduced to epiphenomena arising from configurations of particles of matter in time and space (Heylighen et al. 2007).

According to Heylighen et al. (2007), this worldview assumes that all phenomena, including ourselves and our minds, are equal to the sum of their parts. ‘Being’ is simply the static condition of an object located in space. A system evolves as its elementary particles move about. However:

…there is no way for particles to merge, divide, appear or disappear… everything that exists now has existed from the beginning of time and will continue to exist, albeit in a somewhat different configuration. (Heylighen et al. 2007).

Thus, once the initial conditions of the universe have been established, everything that follows is the inevitable result of the domino-cascade of cause and effect, every event the result of a continuous chain of prior events (i.e. upward causation, or efficient causation as defined by Aristotle). With complete and accurate information, the future of any part of a system can be predicted with total confidence. Philosophers call this understanding of how the world works physical determinism.

In such a world, there is no free will, no true novelty or creation (Prigogine & Stengers 1984), no chaos, mystery or miracles, just predictable rearrangement of matter through cause and effect (upward-causation). This view of a world without uncertainty was famously described by the brilliant 18th century French mathematician, Pierre Laplace:

> An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes. (quoted in Capra 2010, p.57)

As such, the spirit of the scientific revolution was the belief that by using empirical methods and applying Descartes’ coordinates and Newton’s mechanical laws and differential equations, everything in the universe could be reduced to a point where it could be explained and predicted (Briggs & Peat 1989).

**A1.4 Romantic & Industrial Eras**

**A1.4.1 Rise of Idealism**

Philosophers such as Hobbes, Gassendi, and Marx embodied the ethos of the scientific era by embracing materialist philosophies and rejecting the notion of a separate spirit or mind substance. The way materialists think about the world is predicated (very generally) on two key assumptions:

1. The exterior world is real, independent of us, objective and knowable (the materialist metaphysics/ontology)
2. Knowledge is created as we observe the world and our senses send data about it to our minds (the materialist epistemology, otherwise understood as realism) (Ridling 2001; Ritchie & Lewis 2003)

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Versus divine determinism, whereby events are caused by God (Psillos 2004), which is also seen to exclude free will.

*Note that many materialists of the time still believed in God; for example, Hobbes came to believe even God was some form of material being (Duncan 2013).*
Appendix 1

In the 18th and 19th centuries, however, idealist philosophies grew strength as followers of the Romantic Movement revolted against the industrial revolution, rejected notions of a purely mechanistic universe, and embraced the natural world (Barry 1999; Encyclopaedia Britannica 2013). Philosophers of the time, such as Kant, were also attempting to bridge the epistemological divide between rationalism and empiricism created during the scientific revolution (McQuillan 2012). In contrast to materialism, idealist philosophies\(^8\) prioritise the mental, spiritual or abstract nature of reality over the physical. There are several variations of idealism, differing in the relative importance they give the material world, with more extreme varieties positing that space and time are purely mental constructs; *solipsism* for example, which postulates that the only thing sure to exist is one’s own mind (Solomon & Higgins 2004). Idealism rejects the notion of a strictly deterministic universe shaped purely by cause and effect, asserting that mind, or consciousness, is able to exert free will and shape reality (Becker 2004) through a process of ‘downward causation’. Very generally, the way strict idealists think about the world is predicated on two key assumptions:

1. the existence of the external world is dubious and subjective (idealist metaphysics/ontology)
2. knowledge is subjective and inside our minds; we can only apprehend the world as sensations and ideas in our minds so we cannot truly know it (idealist epistemology) (Solomon & Higgins 2004)

Berkeley, for example, was a proponent of an extreme form of idealism known as subjective idealism, which denies the existence of any material substance and argues that objects only exist in the minds of observers (deVries 2004). In the 18th century, Kant set off the ‘Copernican revolution of philosophy’ by merging scholasticism, empiricism and rationalism to devise transcendental idealism (also known as empirical realism), which dominated philosophy into the 19th century. Transcendental idealism accepts the existence of an independent material reality, but argues that we can never truly know it because our mind shapes our experience of reality (McCormick 2005). Philosophy in 19th century Germany and Britain came to be dominated by Hegel’s absolute idealism, which posits that objects must exist in our consciousness (via a thought by God) before they can become real and material (McQuillan 2012). Hegel also revived the ancient works of Heraclitus, and as such, saw the universe as ‘becoming’ in dialectic process of being and non-being (deVries 2004). Hegel also rejected reductionism and atomism: he believed objects had universal qualities that could not be reduced to a set of properties and that objects should be treated as primary wholes (Stern 1990).

### A1.4.2 Panpsychism

Other monist philosophers, such as Spinoza and Leibniz in the 17th century, adopted the idea of *panpsychism*, which straddles the idealist-materialist divide by claiming that everything has a mind and a soul, therefore all things are both mind and matter (Skrbina 2007). Similarly, in the 18th century, La Mettrie and Diderot advanced ‘vitalistic materialism’, which discarded the notion of ‘soul’ in favour of the idea that a mind-like nature was present in all matter (Skrbina 2007). Panpsychism also developed rapidly among 19th century German philosophers, such as Schopenhauer and Goethe, who argued against the division of mind and matter: “no matter without mind, no mind without matter” (Skrbina 2007). The German idealists and panpsychists of the 18th and 19th centuries also revived ancient holist traditions, and focused on nature in its organic form, in opposition to the Cartesian view of the world as a machine (Capra 1997). For example, Kant believed that science could only offer mechanical explanations that could not be used to understand life, which he saw as self-organising wholes (Capra 1997). Likewise, Goethe viewed nature as a great, singular, harmonious whole (Capra 1997).

### A1.4.3 Vitalism

During this time a complementary thread of thinking was revived among 19th century biologists: the ancient doctrine of vitalism. Vitalist biologists opposed reductionism, believing that chemical and physical laws could not adequately explain ‘life’ (Capra 1997). In contrast to Descartes’ notion

\(^8\) Philosophical idealism should not be confused with political or ethical idealism, which is the prioritization of ethics and values over pragmatic concerns.
that animals and human bodies are mechanical ‘automata’, the vitalists believed some underlying force—perhaps in the form of spirit, fluid, or organizing principle—was responsible for giving bodies life (Bechtel & Richardson 1998). Among their number were microbiologist Louis Pasteur and embryologist Hans Driesch (Bechtel & Richardson 1998). By the early 20th century, a number of physicists, including Bohr and Schrodinger, took up vitalist thinking in their belief that organisms are subject to unknown physical laws, unlike those which govern inert matter (Mayr 1988). An important aspect of the vitalist doctrine was the belief that living things have a purpose, or a final goal. As such, living things originate with an ‘enfolded’ blueprint which causes them to develop, or unfold, into that which they were intended (Bechtel & Richardson 1998); i.e. their parts self-organise into a pre-ordained whole. This idea, known as ‘formative teleology’⁹, has its origins in Aristotle’s final causes. Formative teleology was also a central feature of Kant’s idealist notion that living things develop with purposeful intelligence, that their purpose is to reach their final, predetermined forms (Stacey et al. 2000). Just as deterministic notions of a mechanistic universe governed by cause and effect eliminates the possibility of true novelty emerging, so does formative teleology (Stacey et al. 2000). Notably, in an attempt to maintain the notion of free will, Kant did not apply this formative teleology to humans, rather he suggested humans are subject to a ‘rationalist teleology’, whereby they have the freedom to develop their own purpose and therefore create novel outcomes, as human choice cannot be known in advance (Stacey et al. 2000). By the early 20th century, vitalism fell away in favour of a number of new theories in biology, including holism, evolution and organicism.

A1.4.4 Darwinian Evolution

During the latter half of the 19th century, the microscope was invented and mechanistic views came back into favour as major advances were made in biology (Capra 1997). In 1859, against the backdrop of British colonial exploration, Darwin and Wallace proposed the Theory of Evolution. The theory was premised on the belief that all species have diverged from common ancestors through a process of ‘natural selection’. Natural selection acts on chance variation; organisms having traits that enable them to ‘fit’ their environment and survive competition will pass these traits on to next generations. As species evolve and diverge through the ‘survival of the fittest’, natural systems become more complex and ordered over time (Kauffman 1995).

From the time of Aristotle, Western society had largely believed in ‘final causes’, that there was a cosmic force in the world driving all things to greater perfection (Mayr 1999). Darwin, however, did not believe in the notion of ‘soul’, and his theory denied the role of any ‘cosmic teleology’¹⁰; rather, he saw evolution as purposeless with no end in mind (Mayr 1999). For this reason vitalists were very much opposed to Darwin’s theories¹¹.

 Darwin’s theories came to have enormous impact on modern thought, not only shaping science, but also the Western outlook and way of life into the 20th century (Mayr 1999). For example, the term ‘survival of the fittest’ led to social Darwinism whereby evolutionary theory was applied to justify social progress of superior groups (Barry 1999). This resonated with Britain’s colonial aspirations and later with fascism and Nazism in Europe. Through Darwin, Western culture became embedded with belief in the intrinsic necessity of competition in creating ‘healthy’ systems, a belief that persists to this day¹² (Barry 1999).

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⁹ Teleology is the explanation of phenomena by the purpose they serve, rather than by what caused the phenomena (oxforddictionaries.com). A process or a thing is teleological when it is for the sake of its end.

¹⁰ Whereas Darwin felt the soul was a product of evolution, Wallace did not (Wallace 1910). Wallace was similar to the vitalists in his belief that the universe had a purpose, and that supernatural agency was necessary to explain certain aspects of life.

¹¹ Darwin’s theory created much debate about teleology, which has carried on to this day. Some have argued that there is no teleology in his theory, as it is based on chance variation (e.g. Dawkins 1986), while others argued that the notion of adaptation is in fact teleological, in that purpose of an organism is to be adapted to its environment so it can survive (Lennox 1993). Mayr has countered this by stating that that “adaptedness... is a posteriori result rather than an a priori goal-seeking,” (Mayr 2004, p.58).

¹² A striking example of the political currency attained by Darwin’s survival-of-the-fittest notion is illustrated by Kennedy’s 1961 announcement during the Cuban Missile Crisis: "The complacent, the self-indulgent, the soft societies are about to be swept away with the debris of history. Only the strong … can possibly survive," (quoted in Chomsky 2012).
A1.4.5 Thermodynamics - Entropy

Another major scientific advance of this era was that of thermodynamics. From the 1700s, scientists and engineers had been puzzling over why it was not possible to invent a perpetual motion machine—whenever energy was fed into a machine, despite recycling efforts, some of it was always mysteriously lost, requiring continuous inputs of replacement energy (Briggs & Peat 1989). In the 1824, while working on steam engines, the French physicist Sadi Carnot realised that mechanical energy was not actually lost; rather it was dissipated as heat, which is disordered energy the system cannot use again (Prigogine & Stengers 1984). This understanding was formulated into the second law of thermodynamics, stating that closed systems (systems with no external inputs of matter or energy) always tend to move from order to disorder, with disorder steadily increasing over time. Physicists coined the word ‘entropy’ to describe the disorder in a system. Entropy introduced the ‘arrow of time’ into science, by showing that closed systems proceed in a particular direction (from order to disorder), which cannot be reversed (Prigogine & Stengers 1984).

Thus the Newtonian assumption that all phenomena in the universe are mechanically reversible was being challenged on two opposing fronts, one brought into play by classical thermodynamics, which suggested a world becoming increasingly disordered, where “the entire world-machine is running down and will eventually grind to a halt” (Capra 1997, p.98), and another brought on by Darwin’s theory of evolution, which creates a picture of a living world “unfolding towards increasing order and complexity” (Capra 1997, p.98).

A1.4.6 Statistical Mechanics/ Probability Theory

In the 1870s, Ludwig Boltzmann, a Viennese physicist, devised probability theory (also known as statistical mechanics) as a means of reconciling Newton’s laws with the notion of entropy (Prigogine & Stengers 1984). Probability theory suggests that the movements of the trillions of atoms that comprise matter are so complicated that it becomes less likely over time that they will stay in ordered relationships, i.e. they trend towards disorder, or entropy (Capra 1997). Ordered arrangements of atoms and molecules are highly unlikely, and when they do occur, they break down quickly. Eventually the entire universe will dissolve into random disorder (i.e. chaos) and become an inert, homogenous soup (Briggs & Peat 1989). From Boltzmann’s theory it was believed that eventually science would learn to control and predict the behaviour of complicated systems, and minimize or circumvent entropy by understanding its underlying mechanism (Briggs & Peat 1989).

A1.5 Machine Age

A1.5.1 Organicism

As vitalism fell out of favour, a number of biologists in the early 20th century took up the concept of organicism, based on insights from philosophers such as Goethe and Kant (Capra 1997). Among these were the embryologists Ross Harrison, Paul Weiss, and Joseph Needham (Gilbert & Sarkar 2000), and philosophers of biology E.S. Russell and J.H. Woodger (Denton et al. 2013). Organismic biologists transcended mechanistic notions in their belief that patterns of ‘organising relations’ were the key to understanding biological form, and that “no separate, nonphysical entity is required for understanding life”, i.e. they rejected both Cartesian reductionism and vitalism (Capra 1997, p.25). They believed that configuration and relationship are unified by ‘pattern’, and that form, structures and properties of life are the result of the reciprocal interplay of component parts; they were particularly interested in the multi-leveled structures of systems within systems (Capra 1997). The roots of organicism can be traced to Plato’s ideas of a living, intelligent universe (McDonough 2010), and to German romanticism of the 19th century (Capra 1997). However, the 20th century movement was influenced by emergentist philosophers, such as C.D. Broad and M. Lloyd, process philosophers, such as Alfred Whitehead, and holists, such as J. Smuts (Denton et al. 2013). Broad used the term ‘emergent property’ in his 1925 treatise, *The Mind and Its Place in Nature*, to describe the unique properties that emerge at higher levels of complexity, properties which cannot be inferred from the nature of their parts (Gustavsson 2010).
Appendix 1

A1.5.2 Ecology

Aristotle and Plato regarded living things as having 'essences' that gave them their form, thereby rendering them as static, unchanging entities (McDonough 2010). As such, prior to the introduction of Darwin’s theory of evolution, nature studies were typically descriptive natural histories (e.g. the works of von Humboldt, Larmarck and Hutton). This began to change when the term **ecology** was first defined by Haeckel in 1866 as the study of relationships between an organism and its natural surroundings (Botkin 2012). In the first decades of the 20th century, ecologists paralleled the work of organismist biologists with their focus on the “irreducible wholeness” of the systems they studied, namely plant and animal communities (Capra 1997, p.32). In 1905 Clements introduced his notion of vegetation communities as superorganisms, which was hotly debated between idealists and realists until Tansley introduced the term ecosystem in 1935 (Botkin 2012; Capra 1997). Vernadsky built on the ideas of Goethe and Humboldt with his 1926 book **Biosphere**, which depicted life as a force creating and controlling the global environment (Capra 1997). In 1925, however, ecology began to part ways with the idealism and organicism when Volterra and Lotka first introduced the principles of thermodynamics to explain predator prey interactions in 1926 (Keller & Golley 2000). In 1927, Elton presented the concept of food webs and the notion that feeding relationships were the central organising feature of ecosystems (Capra 1997); in 1935 Tansley introduced a materialist ecosystem ecology that waged war on holism and superorganisms (Bellamy Foster & Clark 2008). From this point, trophic dynamics—the flow of energy and food through ecosystems—became the dominant focus of ecological studies.

A1.5.3 General Theory of Relativity

Despite inroads made by holism and organicism, Newton’s classical mechanics dominated scientific thinking for 200 years until the beginning of the 20th century. In classic Newtonian physics, space and time are regarded as opposing, independent and unrelated concepts. They are also absolute, in that they appear the same to all observers (Rynasiewicz 2004). However, in 1916, Albert Einstein transcended Newton’s theories with his geometric theory of gravitation: the General Theory of Relativity. Einstein’s theory introduces the notion of the spacetime continuum, which unifies space and time into a fourth dimension (known mathematically as Minkowski space) (Huggett & Hoefer 2009). In this theory, space and time are relative to the motion of observers. By uniting the two on a ‘higher plane’ or dimension (relativistic spacetime) Einstein’s theory echoes Heraclitus’ two thousand year old concept of the ‘unity of opposites’, whereby all phenomena consist of pairs of opposing properties (Capra 2010). What appear to be separate unrelated or opposing phenomena can be seen to be parts of whole when put into the context of a higher dimension. Capra (2010) uses the image of a donut ring sliced by a plane (Figure A1.1) as a metaphor to demonstrate this concept. When viewed in two dimensions the two circles (A and B) appear to be unrelated entities. However when viewed from the higher order 3D perspective, the circles are revealed as being part of the same entity—a donut (C). This phenomenon can also be understood mathematically in the logical theorems outlined in Appendix 2.

Newton’s law of gravitation described gravity as the attractive forces between massive objects; he saw gravity as operating through empty space, but was unable to explain how it transmitted its forces across the vacuum (Huggett & Hoefer 2009). In Einstein’s general relativity theory, gravity is the result of curved spacetime continuum, which he depicts as a two dimensional surface contorted into dips and valleys by the massive objects occupying space (Huggett & Hoefer 2009). Spacetime’s curvature is dictated by the energy and momentum of whatever matter or radiation is present; as such, spacetime is not a fixed background, as per Newton’s absolute notion of space and time, rather it is a dynamical structure that interacts with matter (Wuthrich 2010). Einstein showed that objects continue to move in straight lines through spacetime, but because spacetime is curved, we observe this motion as acceleration (Huggett & Hoefer 2009).

The General Theory of Relativity has had an impressive track record in terms of accurately predicting a wide range of phenomena, including black holes (where the orderly laws of physics break down), background microwave radiation, and the bending of light around planets (Wudka 1998).
Appendix 1

2006). As such, it became one of modern physics’ essential tools. Although an active field, it is now regarded as incomplete because it fails to account for quantum effects (Rickles 2008).

A1.5.4 Emergentism

In 1920 the Australian philosopher Samuel Alexander published his magnum opus *Space, Time and Deity*, which presented a new metaphysical system with unified spacetime as the fundamental entity of the universe (Thomas 2012). Although Alexander outwardly rejected absolute idealism (siding instead with the realist positions of Russell and Moore—see Section A1.5.7), he was nonetheless influenced by the panpsychic philosophies of Kant, and Spinoza, as well as the idealist philosophies of Plato and Hegel; as such, his work has been accused of “slipping absolute idealism in by the back door” (Thomas 2012). His metaphysics also incorporates ideas from Einstein and Minkowski’s theories of spacetime, and mathematical logic (see Appendix 2).

**Figure A1.1.** A donut ring incised by a plane, viewed first in two dimensions then in three, depicting of how two seemingly unrelated phenomena are revealed as parts of a whole when put into the context of a higher dimension (adapted from: Capra 2010).
Thomas (2012) describes the three platforms of Alexander’s system. Firstly spacetime is a ‘real’ entity (not just a void between things) and identical to matter, which gives rise material objects through motion. As such, spacetime is a single vast entity of Motion. Secondly, spacetime gives rise to two kinds of characters: categories and qualities\textsuperscript{14} (see Appendix 2 to see how this relates to mathematical logic). He sees existing things as being continuously connected in spacetime through groupings of motions. Thirdly, mind emerges from matter (i.e. spacetime), in a process that can be applied to the universe as a whole, “to produce a hierarchy of existence in which each layer emerges from the next: spacetime leads to matter, matter leads to mind, mind leads to deity.” (Thomas 2012). While well received at its publication, Alexander’s work has since been neglected and is now relatively unknown (Thomas 2012).

\textbf{A1.5.5 Process Philosophy & Holism}

In the 1920s reductionism was being challenged on another front by the process philosophy of Alfred Whitehead and the holist concepts of the South African Statesman Jan Smuts\textsuperscript{15} (Heylighen et al. 2007). Inspired by Clements’ notion of the ‘superorganism’, Smuts (1927) fused Darwin’s theory of evolution with Einstein’s theory of relativity (Moller 2006). From this fusion he devised the term holism, defining it as nature’s fundamental tendency to dynamically form wholes that are greater than the sum of their parts. Smuts foreshadows the findings of complexity scientists later in the century (see Appendix 3) with his notions that the whole and its parts reciprocally influence and determine each other, and that holism is a self-reproducing evolutionary force. Einstein was so impressed that he stated Smut’s work, together with his own, would guide human thinking into the 21\textsuperscript{st} century (Hague 2013).

Whitehead was a highly regarded mathematician who had published the ground-breaking \textit{Principia Mathematica} with Bertrand Russell in 1927 (see Appendix 2). Whitehead believed it was the West’s ontology of substances that was causing mathematicians and physicists to struggle, as they attempted to treat as ‘substantial’ those phenomena better understood as ‘process’ (Malone-France 2007). This belief led him to write the seminal \textit{Process and Reality} in 1929, which built on Hegel’s ideas, and disputed Newton’s cosmology of bits of matter floating around in absolute space and time (Whitehead & Sherburne 1981). Whitehead’s process philosophy revives Heraclitus’ notions of the ‘continuous flow’ of reality, and of reality as a ‘process of becoming’ through tension between opposites. It is also related to the dialectic of ‘being’ and ‘not being’ elaborated by Hegel in the 19\textsuperscript{th} century (Whitehead & Sherburne 1981). The foundational argument of process philosophy is that reality is better understood in terms of processes than as things, and that reality is premised on change (Rescher 2008). This is in stark opposition to the idea that reality is primarily made up ‘things’ (with change being secondary or accidental) that has biased Western metaphysics and science since the time of the early Atomists and Aristotle (Rescher 2008).

In process philosophy, reality has no material foundation; what we perceive as substantial entities, or matter, are actually just composites of indefinite “fluctuating processes organized into stable structures” (Rescher 2008). Whitehead uses the term ‘actual occasions’ to describe the smallest units of process that comprise reality, ephemeral “drops of experience, complex and interdependent” (Whitehead & Sherburne 1981,p.205). Whitehead premised his theory on Einstein’s notion of a unified spacetime (Nixon 2010). As such, he defines an actual occasion as “a momentary experiential event which occupies (or constitutes) a region that is spatial as well as temporal” (Griffin quoted in Nixon 2010). These ‘actual occasions’ interact in a continuous process of bringing forth the future. Each moment in reality can be seen as a freeze frame, whereby “the many enter into complex unity” (Whitehead & Sherburne 1981, p.34); “The universe is thus a creative advance into novelty,” a creative flow of ‘becoming’ (Whitehead & Sherburne 1981, p.33). As such novelty is not just possible, it is continuously emerging; the universe is not deterministic, and the arrow of time cannot be reversed.

\textsuperscript{14} In Alexander’s view all motions or things have characters which are either variant, meaning they are qualities (e.g. colour, shape, consciousness) or pervasive, meaning they are categories (e.g. identity, substance, order, diversity, magnitude and number). These categories can apply to all things and are therefore fundamental properties of spacetime (Thomas 2012).

\textsuperscript{15} Jan Smuts was also established and designed the League of Nations.
Whitehead (1981) also believed that Aristotle had “led to a wild overstressing of the notion of final causes during the Christian age; and thence, by a reaction, to the correlative overstressing of the notion of ‘efficient causes’ during the modern scientific period” (p.29). As such, Whitehead proposes a compromise between final and efficient causality: while each emerging moment is novel, it is simultaneously constrained by the past. The configuration of ‘actual occasions’ that comprise a given moment is somewhat consequential on every moment that preceded it (i.e. cause and effect). In other words, while the self-creating unity of the universe (the final cause) ensures every moment is new and different from the previous, cause and effect (efficient causes) results in each moment typically being similar to that which preceded it (Whitehead & Sherburne 1981). Seemingly enduring ‘things’ are actually just stable patterns in time. Time gives immaterial reality the illusion of substance.

In addition to providing a synthesis between final (downward) and efficient (upward) causality in the universe, Whitehead’s process philosophy is considered a bridge between materialist and idealist philosophies, and a development in the panpsychic ideas of the previous century (Skrbina 2007). Whitehead did not believe in the division of mind and matter: while he describes God as the primordial basis of all ‘actual occasions’, God is nonetheless an actual occasion himself, as is the remainder of the universe (Whitehead & Sherburne 1981).

**A1.5.6 Quantum Theory**

**A1.5.6.1 Immaterial nature of reality**

In the 1920s, discoveries in quantum physics finally exploded the materialist paradigms of Cartesian reductionism and classical Newtonian mechanics by demonstrating that the universe cannot be reduced to independent elementary units, rather it is a “complicated web of relations between various parts of a unified whole” (Capra 2010, p. 138). Apparently solid material objects were shown to dissolve into “wave-like patterns of probabilities” at the subatomic level (Capra 1997, p.30).

Further exploding the material conception of the universe was the finding that these patterns of probabilities were not of ‘things’, but of interconnections; while molecules and atoms consist of subatomic particles, these particles are not isolated things in the Newtonian-atomic sense. Rather, they are interconnections between things, which in turn are interconnections between other things, and so on (Capra 1997). Thus, in keeping with Whitehead’s process philosophy, in the end there are no ‘things’, only interconnections. Descartes’ belief that all phenomena could be infinitely subdivided, that there are no indivisible pieces of matter in the universe, was shown to be a more accurate view of reality than that of Newton and other atomicists. In the words of Niels Bohr (1958, p. 57), “Isolated material particles are abstractions, their properties being definable and observable only through their interactions with other systems.” Henry Stapp elaborated by noting:

> An elementary particle is not an independently existing unanalyzable entity. It is, in essence, a set of relationships that reaches outward to other things. (quoted in Capra1997, pp.30-31)

Quantum theory expresses these relationships as probabilities determined by the system whole (Capra 1997). According to Heisenberg, “the world thus appears as a complicated tissue of events, in which connections of different kinds alternate or overlap or combine and thereby determine the texture of the whole” (Heisenberg 1958, p.107). Bohm (2012) also describes how it is the relationship between things, not the things themselves, that give rise to material reality; for example, it is not the ‘things’ oxygen and hydrogen that give rise to the ‘thing’ water, it is the relationship between them. Bohm (2012) argues that this network of relationships is an underlying implicate order that is enfolded in the whole of the universe. Explicate order, on the other hand, consists of those ‘things’ we can observe and measure, and is generated by implicite order, through the relationships between things.

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16 Thus, apparently material things are actually just the “emergence of stabilities in statistical fluctuations” at the microlevel (Rescher 2008). Instead of ordinary processes (like windstorms) being caused by very small things (like atoms), it was actually the combining of very small processes that was producing ordinary things (like a table, or a planet) (Rescher 2008).
Appendix 1

After three centuries as the dominant scientific paradigm in physics, the Newtonian model (whereby the behaviour of the whole is determined by the mechanical interactions of material parts) was reversed by quantum mechanics, showing that at the subatomic level the whole determines the behaviour of the parts, which themselves are just interconnections (Capra 1997). This discovery, that complex systems cannot be wholly understood through analysis—i.e. reductionism, the cornerstone of modern scientific thought—was the “great shock of twentieth-century science” (Capra 1997, p.29).

A1.5.6.2 A Participatory Interconnected Universe

Just as relativity demonstrates a return to Heraclitus’ unification of opposites, so does quantum theory, in its recognition that subatomic entities only come into being through interaction with other entities. But quantum’s most spectacular demonstration of Heraclitus’ philosophy is the famous double-slit experiment17 showing that matter and energy paradoxically behave as both particles and as waves. Whether they act as waves or particles depends on how they are observed (Capra 2010). This wave-particle duality, where particles are also waves, and waves are also particles, cannot be explained by classic Newtonian physics. The paradox can be solved by changing the frame, or dimension, in which waves are understood, from that of a three-dimensional wave (like a sound wave or water wave), to that of a probability wave, which represents the abstract probability of a particle existing in a particular place with particular properties (Capra 2010). This change of frame, however, creates a new paradoxical duality of opposites in that it means particles can never be said to exist or not exist in a particular place:

The particle is not present in at a definite place, nor is it absent. It does not change its position, nor does it remain at rest. What changes is the probability of the pattern, and thus the tendency of the particle to exist in certain places. (Capra 2010, p.154)

Thus, matter and energy come into being through a unity of opposite properties: they are at once both particles and waves, destructible and indestructible, continuous and discontinuous, existent and non-existent (Capra 2010). Solving one paradox about their nature by changing the frame in which they are understood simply creates a new paradox of opposites.

The Copenhagen interpretation of quantum theory also undermines the notion of Cartesian and Newtonian determinism via the Heisenberg Uncertainty Principle18 (Heisenberg 1927). Heisenberg showed that the more precisely you measure one quantity of an entity, e.g. position, the more uncertain other quantities become, e.g. momentum, spin, energy, etc. Thus, no two quantities can be simultaneously measured with precision (Capra 2010). The Heisenberg interpretation argues that this is because through the act of observing, the scientist changes the properties of entity he is attempting to observe. The relational interpretation of quantum theory (Rovelli 1996) suggests that the entity being observed, such as a photon in the double slit experiment, does not possess any absolute properties, rather its observed properties or behaviours arise from the interaction between the observer the observed entity. In either case, by setting up what it is we are going to measure and observe, we determine to some extent the properties of the observed object precision (Capra 2010). As Heisenberg himself stated, “What we observe is not nature itself, but nature exposed to our method of questioning” (1958, p. 81). As such, the idea of a scientist playing the role of detached observer is shattered, and Kant’s transcendental idealism is revived. Capra (2010) evokes Wheeler to describe the phenomena:

Nothing is more important about the quantum principle than this, that it destroys the concept of the world as ‘sitting out there’, with the observer safely separated from it by a 20 centimetre slab of plate glass. Even to observe so miniscule an object as an electron, he must shatter the glass. He must reach in. He must install his chosen measuring equipment. It is up to him to decide whether he shall measure position or momentum. To install the equipment to measure the one prevents and excludes his installing the equipment to measure the other. Moreover, the measurement changes the state of the electron. The

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17 A short and simple animated description of the double slit experiment can be viewed on http://www.youtube.com/watch?v=DfPepnQ7oGe. The animation is a relational interpretation of the results.

18 This Copenhagen Interpretation of quantum physics has been disputed by a number of other mathematical theories.
universe will never afterwards be the same. To describe what has happened, one has to cross out that old word ‘observer’ and put in its place the new word ‘participator’. In some strange sense the universe is a participatory universe\textsuperscript{19}. (p.141)

The famous American quantum physicist David Bohm also regards the universe as an undivided whole, despite being one of the main opponents of the Copenhagen Interpretation. Bohm (2012) states: "The new form of insight can perhaps best be called Undivided Wholeness in Flowing Movement" (p.11). His view implies that flow is, in some sense, prior to that of the ‘things’ that can be seen to form and dissolve in this flow. Bohm evokes the metaphor of vortex in a flowing stream to describe his conception, noting that vortices are stable patterns within a continuous flow; the vortex is undivided from and contiguous with the stream, which itself (as the whole) is in a constant state of flux (Bohm 2012). From this we see yet another return to the pre-Socratic thinking of Heraclitus, whereby the world is in a state of continuous change, and the notion that we can never step into the same river twice.

\textbf{A1.5.6.3 Indeterminism: Merging Mind and Matter}

Quantum indeterminism opened the door to downward causation, suggesting we can exert free will (Eddington 1928) and that not everything is predictable and predetermined (Heisenberg 1927). Materialist notions of a universe filled with objects existing independently of the human mind gave way to idealism among many early 20\textsuperscript{th} century physicists, who thought perhaps there could in fact be a ‘ghost in the machine’, some form of universal consciousness helping to shape reality, perhaps even God. For example, the physicist Sir James Jeans (1930) wrote,

…the stream of knowledge is heading towards a non-mechanical reality; the Universe begins to look more like a great thought than like a great machine. Mind no longer appears as an accidental intruder into the realm of matter; we are beginning to suspect that we ought rather to hail it as the creator and governor of the realm of matter—not of course our individual minds, but the mind in which the atoms out of which our individual minds have grown exist as thoughts. (p. 137)

Jeans further expounded on the movement of physics toward idealism when addressing the British Association in 1934:

What remains is in any case very different from the full-blooded matter and the forbidding materialism of the Victorian scientist. His objective and material universe is proved to consist of little more than constructs of our own minds. To this extent, then, modern physics has moved in the direction of philosophic idealism. Mind and matter, if not proved to be of similar nature, are at least found to be ingredients of one single system. There is no longer room for the kind of dualism [separation of mind and universe], which has haunted philosophy since the days of Descartes. (James 1934)

Likewise, Bohm (1993) suggests that consciousness is deeply rooted in the universe’s ‘implicate’ order, and therefore present to some degree in all material forms, as a “rudimentary mind-like behaviour of matter”. D’Espagnat (1979) notes that experimental results from quantum physics dispute the notion of a world existing independently of human consciousness. This view, that the fundamental physical components of the universe have mental properties, signals a return to the monist notions espoused in Spinoza’s panpsychism and a radical departure from the dominant mechanistic conception of the universe. Bohm is a panpsychist, as is fellow quantum theorist, Hameroff (Skrbina 2007). As such, Skrbina (2007) argues that panpsychism is no longer in question, rather it is a matter of what form it takes.

\textsuperscript{19} Capra (2010) notes that while the participator notion is relatively new to modern physics, it has long been a central tenet of eastern mysticism, whereby it is believed that knowledge can only be obtained through full participation, never by observation alone; indeed some mystic traditions believe observer and subject are both inseparable and indistinguishable.
Appendix 1

A1.5.7 Wittgenstein

In 1921 the Austrian philosopher Ludwig Wittgenstein published his seminal *Tractatus Logico-Philosophicus*. Wittgenstein was largely influenced by his conversations with the mathematician Bertrand Russell about the foundations of logic and philosophy (Biletzki & Matar 2009). In the *Tractatus*, Wittgenstein applies modern logic to reveal the relationship between language and reality. He was particularly concerned about the distinction between things that can be expressed using language (i.e. thought), versus those which can only be shown, which he felt to be the principal problem of philosophy. He believed that the underlying logic structure of language limits what can meaningfully be said and thought about the world, particularly in relation to language itself and to metaphysics (Biletzki & Matar 2009). His main premise was that the structure of language is determined by the structure of reality (Jashapara 2004). Thoughts, and therefore language, are accurate ‘pictures’, or models, of the world; anything that cannot be ‘pictured’, is therefore beyond language, and is ascribed as ‘nonsense’ (Biletzki & Matar 2009). Thus, mystical philosophical concerns, such as metaphysics, aesthetics and ethics, though meaningful, cannot be discussed in a way that is not ‘nonsense’ (Biletzki & Matar 2009). Wittgenstein believed that the limits of language and thought should be the limits of philosophy. Thus philosophy should be discarded for logical practices that reflect the ‘real’ world (i.e. that which can be ‘pictured’), as attempts to discuss anything external to the real world, i.e. the mystical world, result only in nonsense (Biletzki & Matar 2009).

Despite his apparent dismissal of metaphysics, Wittgenstein makes his own materialist and realist metaphysics evident in the book, stating his belief that the substantial world consists of objects, and that human thought and language represent an accurate picture of the world (Biletzki & Matar 2009). As such, in contrast to the quantum revelations of the same decade, Wittgenstein clearly ascribes to an independent, material and knowable world.

Wittgenstein’s works have been widely interpreted and debated and have gone on to influence almost every discipline within the humanities and social sciences, including logic, language, perception, culture religion and ethics (Biletzki & Matar 2009). His work was also central to the emergence of logical positivism, and the subsequent marginalisation of traditional philosophy and rise of radical empiricism within the natural sciences.

A1.5.8 Vienna Circle – Logical Positivism

Despite its obvious compatibilities with the new quantum science, Idealism’s sway over Western metaphysics declined in the 1920s when it was overtaken by materialist, empirically oriented philosophers (Uebel 2011). Vienna was the scene of much intellectual ferment in the 1920s. A varied group of scientists and philosophers, calling themselves the Vienna Circle, met weekly to discuss problems in the philosophy of science and mathematics (Hawking 2007). Inspired by Wittgenstein’s insights about logical truths and seeming opposition to metaphysics (Wittgenstein himself said he was misinterpreted by the Circle), the Circle took a strong empiricist and positivist stance, tasking themselves with “clearing the stables of academic philosophy,” challenging its legitimacy and traditional role (Uebel 2011). Rationalist and idealist epistemologies (e.g. Descartes, Leibniz, Spinoza and Kant) premised on the notion that knowledge can be gained a priori through intuition, thought and reason, were bitterly opposed. For the Circle, the only meaningful a priori knowledge was derived through analysis, formal proof using logic or mathematics. As such, the Circle relegated the role of philosophy to that of clarifying assertions and problems though formal logical analysis (analytic philosophy). Metaphysics, theology and ethics were viewed as meaningless nonsense and discarded altogether. Synthetic empirical statements were only meaningful if they could be somehow tested in the field. So it was that the Vienna Circle expanded the domain of empiricism and shrunk the role of philosophy in science (Uebel 2011). In doing so they brought forward an extreme form of empiricism called logical positivism, premised on the notion that statements were only true or meaningful if they could be verified by observation (a posteriori). They advocated induction-based approaches to generating theory, a posteriori from facts. In this view, science progresses by generating facts through experiment and observation, and then logically deriving theories that fit the facts through a process of induction (Uebel 2011).
Appendix 1

With WWII looming, the Vienna Circle dispersed, creating an exodus—mostly to the USA and UK—as many of its members fled or emigrated under fear of mounting Nazism (Uebel 2011). Thus logical positivism spread from its origins in Vienna to have an enormous influence across the Western world, where it remained the dominant philosophy of science until the 1950s, when it was overtaken by scientific realism.

Logical positivists have been widely criticized as “lacking historical consciousness and any sense of the embedding of philosophy and science in the wider culture of the day” (Kuhn 1962; Uebel 2011). Their critics have also argued that in insisting that only what can be empirically observed is real, positivists have confused ontology with epistemology—assuming that the map is the territory, so to speak (Pratt 1997). Eventually the positivist’s inductive approach to generating theory was found to be unsubstantiated: despite claims about the neutral objectivity of science, observation is nonetheless inevitably guided by theory of some sort (Chalmers 2002). Purely inductive approaches also render it impossible to make theory about unobservable entities such as electrons. In addition, many of the positivists’ inductive theories were so broad and flexible that they could never be disproved (Chalmers 2002). Karl Popper, a Vienna educated philosopher, reacted against their inductive theories by arguing that good theory should be structured such that it is falsifiable (Popper 1979). His work later led to the later ascendancy of scientific realism (see Section A4.6.3).

A1.5.9 Systems Theory

Ludwig von Bertalanffy was a biologist who was part of the Vienna Circle during the 1920s. He was influenced by the ‘systems-thinking’ of organicist biologists, process philosophers, holists, ecologists and quantum physicists in the early 20th century, which focused on “connectedness, relationships, context,” (Capra 1997, p.29). Bertalanffy wanted to replace the mechanistic foundations of science with a holistic one founded in biology rather than physics (Capra 1997). The systems view of living systems was one of wholes emerging through the interactions of their parts, of which they are greater than the sum of (von Bertalanffy 1969). Systems-thinking was the antithesis of reductionism, in that the properties of living systems were seen to be “destroyed when the system is dissected either physically or theoretically, in to isolated elements” (Capra 1997, p.29).

In the 1930s, Bertalanffy combined the systems-thinking ideas of the time to devise a formal theory of living systems (Capra 1997). Bertalanffy was familiar with the mathematical and mechanical models used to describe physical systems, but observed that the systems they described were closed and close to equilibrium. Living systems, on the other hand, are open systems operating far from equilibrium, feeding on continuous flow matter and energy from their environments (von Bertalanffy 1969). Living systems are not static compositions of molecules and matter, rather they are characterised by continual flow and change, as they exchange constituents with their environments. They are comparable to a vortex in a stream, a stable ordered structure, far from equilibrium, formed by the constant through-flow of water; if the water stills, the vortex collapses. Likewise, without a constant through flow of matter and energy, complex living systems die and decompose into disorder (von Bertalanffy 1969).

Bertalanffy used the idea of order forming in open systems far from equilibrium to reconcile the opposing notions of a world becoming increasingly simple and disordered, via the second law of thermodynamics, and a living world becoming increasingly complex and ordered, via Darwinian evolution (Capra 1997). Because living systems are open systems existing in a steady state far from equilibrium, the second law of thermodynamics, which deals with closed systems near to equilibrium, cannot apply. Unlike closed systems, in open systems, entropy can actually decrease (Capra 1997).

Heylighen et al. (2007) describe a number of concepts that are features of systems theory. A system is separated from its environment by a boundary, which gives it identity, and across which matter, energy and information are exchanged as inputs and outputs. Systems become coupled together as outputs of one system are used as inputs by another, creating feedback loops. Systems which incorporate feedback are non-linear; thus, they cannot be accurately described using Newton’s linear differential equations, the relevance of is discussed in Appendix 3. When multiple systems couple, they form a network, which, upon reaching sufficient coherence, becomes a supersystem.
Systems and supersystems are organised into hierarchies, extending upward to larger wholes, and downward to smaller subsystems. The theory has a black box view of subsystems: they are seen as abstract relationships and the processes they perform within the larger whole, rather than as independent material components. The structure of subsystems is considered irrelevant to their function, e.g. neurons and transistor chips perform the same information processing function, and are considered isomorphisms. Thus, systems theory looks at the patterns of organisation that are common to all phenomena, rather than a phenomenon’s material parts. Systems theory applies reductionism when looking downward at subsystems (i.e. upward causation), and emergence and holism when looking upward at the system whole (downward causation); both are equally important. Systems coupled into supersystems are constrained by the downward causation exerted by the whole, meaning they have to obey the rules of relationship that maintain the coherence (i.e. emergent properties) of the supersystem and can no longer act independently (Heylighen et al. 2007).

As systems-thinking was taking hold among scientists and philosophers of the time, biology had been making inroads in the areas of homeostasis and metabolism. Bertalanffy realised that metabolic processes were responsible for living things achieving steady state, which in turn led him to postulate ‘self-regulation’ as another key property of living systems (Capra 1997). He also believed that the reason so many concepts and laws could be applied to different fields (e.g. biology, chemistry, physics) was because these concepts and ideas all dealt with systems (Capra 1997). As such, he believed a general systems theory, a theory of ‘wholeness’ could unify the various scientific disciplines that had become fragmented over time, and that a new thermodynamic theory would be needed for describing open systems (Capra 1997). Although this did not happen until 30 years later, when Ilya Prigogine developed the notion of dissipative structures (see Appendix 3), Bertalanffy’s work formed a major scientific movement, which together with cybernetics, led to later applications in systems engineering, systems analysis and systems dynamics (Capra 1997).

A1.6 Post-war Era

A1.6.1 Cybernetics

While Bertalanffy worked on his general systems theory, an interdisciplinary group of mathematician-philosophers, neuroscientists, and engineers, together with a group of humanities scientists, met from 1946 to 1953 in a series of creative New York meetings called the Macy Conferences (Heylighen & Joslyn 2001). Among the eclectic group were the following: genius mathematician and philosopher Norbert Weiner; quantum theorist, mathematician, game theorist and logician, John von Neumann; electronic engineer and mathematician, Claude Shannon; biologist, anthropologist, psychiatrist and epistemologist, Gregory Bateson; anthropologist, Margaret Mead; psychologist, Kurt Lewin; and psychiatrist and physiologist, Warren McCollough (Heylighen & Joslyn 2001). From these meetings, the group devised a framework for the emerging field of cybernetics20, which is concerned with communication and control, specifically natural and mechanical self-regulating systems. Early cybernetics was built on an odd admixture of earlier WWII military research and research attempting to express neural mechanisms of mental phenomena in mathematical language (Capra 1997; Heylighen & Joslyn 2001).

Cybernetics is concerned with patterns of self-regulation in both organisms and machines. Feedback is the centerpiece of cybernetic thinking, which distinguishes it from other types of mechanistic thinking (Capra 1997). Feedback is the circular linking of causally connected elements in a system. The circularity of its connections means the first input of the cybernetic system is affected by its last output every time the system cycles, making these systems non-linear. When the feedback loop is negative21, deviations from equilibrium are suppressed, and the system becomes self-regulated (Heylighen et al. 2007). An example of a simple mechanical feedback system is the thermostat. The

20 The term ‘cybernetics’ is derived from the Greek word for steersman: kubernetes. The word was also transformed in Latin to gubernator, which translates into the English ‘governor’ (Beer 2002).
21 When positive and negative feedback links combine in a loop, if the negative links are odd in number the overall effect will be negative feedback, whereas if there are an even number of negative links, the overall effect will be positive (Capra 1997).
cyberneticists also turned their minds to feedback cycles in living systems. They believed that self-regulating systems, both living and mechanical, maintained their autonomy and identity (i.e., cohesion) through ‘purposeful’ action, which is goal directed and apparently intelligent (Ashby 1964; Heylighen & Joslyn 2001). The cyberneticists also identified feedback as the underlying mechanism of self-regulatory metabolic processes that create homeostasis in living things, and thereby the source of life’s general pattern (Capra 1997). Two types of feedback links were recognised: negative, or self-balancing feedback, and positive, or self-reinforcing feedback, also known as ‘run-away’ or amplifying feedback (Capra 1997). The cyberneticists focused on self-regulating negative feedback systems, those which dampen change and maintain stable states, paying little attention to positive run-away feedback until the 1960s. Cybernetic machines incorporating feedback became a central focus of engineering at this time (Capra 1997).

According to Heylighen et al. (2007) research arising from cybernetics has shown that ‘intelligence’ is generated by the patterns of feedback relations that transform sensory inputs into motor outputs. The greater the variety of perturbations a system faces, the greater the variety of compensating feedback loops it will require to maintain cohesion. The system will also require greater ‘intelligence’ in terms of knowing what compensatory feedback loops to apply in a given situation (Heylighen et al. 2007). Thus, in the cybernetic view, Cartesian duality is solved, as mind and matter are both simply patterns of relations (Heylighen et al. 2007). In giving relationship primacy over matter, cybernetics can be seen as more aligned with the ontologies of panpsychism, process philosophy and quantum theory than it is with the material and mechanicanistic ontologies of Newton and the Atomicists. Ironically, despite this apparent ontological shift, cybernetic developments in the realm of communication later led to a machine-based conception of the brain and how it works: cognition.

A1.6.1.1 Communication & Cognition

The cyberneticists were also interested in communication patterns and building a mathematical theory of communication (Heylighen & Joslyn 2001). They applied probabilistic mathematics used in thermodynamics to measure information transmitted through telegraph and phone lines, and to explain ‘information entropy’22, which led to the formulation of information theory (Capra 1997). They recognized coded messages as patterns of organisation and introduced the term ‘bit’ as a measurement unit for information. The cyberneticists also devised theory to describe how communication networks (both living and non-living) regulate themselves by generating feedback loops (Capra 1997). Cybernetic communication/information theory has made important contributions to electrical engineering and computer science. They have also been applied to a variety of other fields, including artificial intelligence, cognitive sciences, neurobiology, molecular evolution, ecological modelling, thermal physics, and human communication in psychology and sociology (Capra 1997; Heylighen & Joslyn 2001). For example Bateson, used communication theory to pioneer cybernetic approaches to family therapy, psychotherapy, schizophrenia, and the concept of ‘mind’ (Bateson 2000).

During the 1950s and 60s, cyberneticists used information and communication theory to help invent sophisticated information processing machines in the form of digital computers and artificial intelligence. At the same time Ashby (1952) was developing cybernetic models of the brain, where the brain was conceived as a logical circuit with neurons as base components. In Ashby’s view, animals, like machines, behave in predictable ways, due to chemical and physical cause and effect (Ashby 1952). Correlations with computer intelligence led to a new cognitive understanding of brain function, where the brain is seen as an information processing machine, much like a computer: rules based, subject to central logical processing, and possessing local storage (Capra 1997). During the late 60s and early 70s Broadbent devised his information processing model of cognition, Putnam devised his computational theory of the mind (Horst 2009), and Neisser introduced the term ‘cognitive psychology’, a field which views people as dynamic information-processing systems (Thomas 2010). The computer sciences further reinforced the mind as a computer perspective by using terms such as ‘intelligence’, ‘memory’, and ‘language’ in relation to computers (Capra 1997).

22 Information redundancy is used as a measure of the relative ‘order’ of an information system, against maximum disorder, or information entropy (Capra 1997).
Because of its links with mechanistic science, engineering and the military, cybernetics held much prestige and influence in scientific institutions, which increased with the rapid spread of computers (Capra 1997). Despite very early arguments that brains “operate on the basis of massive complexity, storing information distributively and manifesting a self-organising capacity that is nowhere to be found in computers” (p. 70), the cybernetic notion of cognition quickly swept these arguments aside and ‘cognition as information processing’ became the basis of cognitive science and brain research for the following thirty years (Capra 1997). Capra (1997) compares the enthusiasm during the invention of computers for the ‘mind as a computer’ metaphor, with the ‘body as a clockwork’ metaphor that so excited thinkers in the days of Descartes, when clocks—at least as revolutionary as computers in their time—had just been invented. Capra (1997) argues that while the ‘mind as a computer’ metaphor was initially a useful framework for scientific understanding, by the 1960s it had hardened into dogma: neurobiology into the 1970s no longer even questioned the origins of and assumptions underlying the information processing approach to cognition. Thus, despite new scientific developments refuting many of the cybernetic models, the cybernetic view of cognition and technology is still widespread (Capra 1997).

A1.6.1.2 Applied Systems Thinking

Cybernetics and systems thinking also had a strong influence on industrial engineering and management in the 1950s and 60s, where it was used to solve practical technological problems in systems engineering, systems analysis and systemic management (Capra 1997). Systems analysis was used by the military in the 1940s for planning and organising operations. It was later adopted by policy makers and technology brokers, and soon morphed into cost-benefit analysis and complex mathematical models for solving organisational problems (Capra 1997). In the 1950s and 60s Jay Forrester developed the field of systems dynamics (see Appendix 4 for details), which models the feedback loops, time lags, stocks and flows that affect the overall behaviour of industrial management systems, and which he later applied to modelling growth in large socio-economic systems (Forrester 1968, 1969, 1971, 1975). The application of cybernetics perhaps reached its zenith in the “rather wild” Chilean Cybersyn project of the early 1970s, headed by British management scientist and cybernetic guru Stafford Beer (Varnelis 2006). The project was designed to control newly nationalised industry as part of President Allende’s plan for the “Chilean Way to Socialism”, by implanting an “electronic nervous system” into Chilean society, a vast communication network run from a government mainframe computer in Santiago (Varnelis 2006). Cybersyn would monitor industrial productivity, material supply, worker absenteeism, etc., and alert the government when such parameters strayed outside acceptable ranges; it would also be used to forecast economic decisions (Barrionuevo 2008). The project was abandoned at its prototype stage when the Allende government was overthrown by an American-supported military coup in 1973 (Barrionuevo 2008).

A1.6.2 Molecular Biology

While systems thinking had considerable influence on engineering and management through the 50s and 60s, it had little impact on biology at this time (Capra 1997). The structure of DNA, the mechanism of heredity central to Darwin’s evolution theory, had been discovered in 1953, radically shifting the emphasis of biological research to molecular biology and genetics. Molecules, as opposed to cells, were now seen as the ‘building blocks’ of life; systems thinking fell away, and mechanism and reductionism came back into favour as structure of DNA was probed (Capra 1997). Biologists came to widely believe that all biological functions could be explained by molecular structures and mechanisms—Capra suggests this resulted in a “severe distortion of biological research” (1997, p.77) which limited biologists’ understanding of integrative functions of DNA in terms of how genes communicate and cooperate.
Appendix 1

A1.6.3 Self-organising Systems

In 1943, the cyberneticists McColluch and Pitts had presented a paper depicting neurons as binary switching elements, and showing that the “logic of any physiological process, of any behaviour, can be transformed into rules for constructing a network” (Capra 1997, p.84). Following their work, scientists began building binary network models from which ordered patterns would spontaneously emerge out of random behaviour, in a process called self-organisation (Capra 1997). This was a shift in focus from cybernetic self-regulating systems, which use negative feedback to correct and stabilise systems. In the late 50s, the physicist and cyberneticist Heinz von Foerster organised an interdisciplinary research group around the study of self-organising systems, at the Biological Computer Laboratory in Illinois. In absence of non-linear mathematics, they attempted to apply the cybernetic notions of information redundancy and entropy to devise a qualitative measure the relative order and disorder of self-organising systems (Capra 1997). This group worked away from the reductionist mainstream of the time, and although not widely published, in the 70s and 80s their work influenced a number of researchers exploring self-organisation in a variety of fields (Capra 1997).

In the late 1960s, the development of high-speed computers led to the formulation of non-linear mathematics. This in turn led to the birth of chaos theory, as theorists starting modelling the non-linear aspects of complex and self-organising systems that could not previously be modelled (see Appendix 3, Section A3.5 for details). Chemist and physicist Ilya Prigogine used non-linear equations to provide the first descriptions of self-organising systems far from equilibrium and devised non-linear thermodynamics from his work on dissipative systems (see Appendix 3, Section A3.3 for details). Around the same time other scientists were discovering the self-organising role of positive feedback (amplification) in open systems far from equilibrium. Physicist Hermann Haken24 developed synergetics with his discovery that laser light spontaneously self-organises (emerges) as a result of amplification caused by energizing disordered light (Capra 1997). Biochemist Manfred Eigen25 discovered that when energized, enzymatic reactions spontaneously self-organise into networks of catalytic cycles called hypercycles (Capra 1997).

The 1970s saw further work on self-organising systems. In 1972 biologists Humbert Maturana and Francisco Varela, also influenced by cybernetics, introduced their theory of autopoiesis (1980) to describe the circular self-organising nature of living systems (see Appendix 3, Section A3.4 for details). In 1973 atmospheric chemist James Lovelock26 came up with his Gaia hypothesis in a

24 Haken discovered the role of non-linearity during his studies on lasers. He found that when a light system was energetically pumped, at a critical value an amplification process would set in, causing laser light (highly ordered, ‘coherent’ light) to spontaneously emerge from the disordered ‘incoherent’ light of conventional lamps. Haken recognised that laser light was an example of self-organisation of systems far from equilibrium, and coined the term synergetics for a new field of study in this area (Capra 1997).

25 Eigen discovered self-organising processes in biochemical systems far from equilibrium. He and his colleagues found catalytic enzymatic reactions exposed to energy flows would self-organise into complex networks of closed loops, or catalytic cycles (Capra 1997). With continued energy flow, over time catalytic cycles will successively self-organise into more and more complex structures called ‘hypercycles’. Each new level of organisation occurs after the system passes through a successive period of instability. These cycles play an essential role in metabolic function of living things, and are so stable that they can persist under a wide range of conditions; they are also capable of self-replication and correction of replication errors (Capra 1997). As such, hypercycles are considered to be precursors to living systems. Eigen also suggests that this process whereby a new, complex structure emerges from a period of instability can be applied to evolution and mutation, whereby by mutation with selective advantage is the equivalent to an instability (Capra 1997).

26 Lovelock had a sudden insight while working on the NASA space program that led him to speculate that life not only made earth’s atmosphere, it also regulated it to keep it favourable for organisms (Capra 1997). Lovelock felt this explained why the earth’s atmosphere is highly unstable and far from equilibrium: because organisms continuously pump oxygen, methane and other gases (i.e. energy and matter) into the atmosphere, making it an open system—the key feature of self-organising systems. Together with Dian Hitchcock, he conducted telescopic spectral analysis of Mars’ atmosphere and found the opposite situation—it was in complete chemical equilibrium, indicating that it is a closed system (energy and matter are not flowing into it). As per the second law of thermodynamics, all possible chemical reactions have already happened, leaving Mars’ atmosphere in an entropic state. So, they hypothesised, there could be no life on Mars. Their findings were disregarded when presented to NASA, who were already planning the Viking space probe’s mission to look for life on Mars. Once the probe landed, it found no evidence of life, as Lovelock predicted (Capra 1997). Lovelock’s insight was based on his knowledge that despite the sun’s heat having increased by 25% since life first appeared on earth, the earth’s surface temperature had subsequently remained at a relatively constant temperature suitable of life. From this he speculated that life was not only regulating the earth’s temperature, but also its atmospheric composition, ocean salinity, etc., just as organisms regulate their own bodies to achieve homeostasis and stay alive despite
Appendix 1

moment of insight while working with NASA, which he later published with biologist Lynn Margulis (Lovelock & Margulis 1974). This hypothesis uses cybernetic principles to describe earth as an evolving complex system that self-regulates through tight coupling between the biosphere, atmosphere, pedosphere and hydrospheres.

…the surface of the Earth, which we’ve always considered to be the environment of life, is really part of life. The blanket of air—the troposphere—should be considered a circulatory system, produced and sustained by life…When scientists tell us that life adapts to an essentially passive environment of chemistry, physics and rocks, they perpetuate a severely distorted view. Life actually makes and forms and changes the environment to which it adapts. Then that ‘environment’ feeds back on the life that is changing and acting and growing in it. There are constant cyclical interactions. (Margulis 1989)

Then in the 1980s Margulis (1989) devised the notion of symbiogenesis whereby a new organelles, bodies, organs and species are formed by the merging of two separate ones. From this she postulated that cooperation is a stronger evolutionary force than competition and natural selection, and that variety is generated through self-organisation as well as through genetic mutation. In the 1990s, scientists with the Sante Fe Institute, notably Stuart Kauffman and John Holland, used computer modelling to advance the complexity sciences, by looking at patterns of order that emerge from the interactions of system agents (see Appendix 3, Sections A3.6 & 7 for details).

Heylighen et al. (2007) note that despite being a natural extension of cybernetics and systems theory, the chaos and complexity sciences developed largely independently, primarily as a result of the new explorations into the complexities of non-linear dynamics that were enabled with the arrival of high powered computers, and interest in biological evolution. The impetus of these explorations was finding new ways of predicting and controlling the behaviour of complex systems. As such, the chaos and complexity sciences emerged firmly out of the Newtonian paradigm (Heylighen et al. 2007) and the tradition of scientific realism that had overtaken the logical positivism of the pre-WWII period.

A1.6.4 Scientific Realism vs. Scientific Paradigms

By the 1950s, the inconsistencies in logical positivism’s fundamental tenets had spawned a countermovement of ‘scientific realists’, who postulated that one can in fact make truthful claims about unobservable entities; i.e. theoretical entities can actually exist even if they are not directly observed changes in their environment. As such, Lovelock postulated that the earth is a self-regulating entity, via the tight coupling between life and its environment. He called his hypothesis Gaia (Lovelock & Margulis 1974). To elaborate on his theory, he later teamed up with the microbiologist Lynn Margulis, who was studying the production and removal of gases by various bacteria. They were able to identify a number of complex networks of tightly interlocked feedback loops, linking living and non-living systems, which they believed resulted in the earth’s self-regulation (Capra 1997).

Capra (1997) illustrates this using the carbon dioxide cycle as an example. Volcanos spew out enormous amounts of carbon dioxide into the atmosphere over millions of years. Excess atmospheric CO2 can cause the earth to heat up to a point where it threatens life, so the Gaia system must find ways of removing it from the atmosphere. Plants and animals use much of the CO2, pumping it out of the atmosphere for photosynthesis, respiration and decomposition. But a dangerous excess of CO2 still remains, so another process is at work. As rocks weather they combine with rainwater and CO2 to produce liquid solutions of various chemicals called carbonates, thus removing CO2 from the atmosphere and converting it to liquid form. Soil bacteria increase rock weathering and therefore regulate the process. The carbonates are washed into the ocean, via rivers and streams, where enormous numbers of microscopic algae use them to build tiny shells of calcium carbonate (this is what beach sand is made from). When the algae die, their shells accumulate on the ocean floor and form massive limestone sediments (also made of calcium carbonate). The weight of these sediments causes them to sink into the molten mantle of the earth and melt. Some of that carbon is then spewed back into the atmosphere as carbon dioxide by volcanos, and the feedback loop is closed. This cycle works as the earth’s thermostat: as the sun gets hotter, the heat stimulates the growth of soil bacteria, which increase weathering, which increases the removal of CO2 from the atmosphere, which cools the earth’s temperature. As the earth cools, the activity of soil bacteria decreases, weathering decreases, less CO2 is removed from the atmosphere, and the earth heats up again (Capra 1997).

Lovelock then developed mathematical computer models of the earth’s self-regulating Gaia system. These models revealed that when the feedback cycles linking living and non-living aspects of the earth’s systems are broken, populations of organisms begin to fluctuate wildly and the system goes chaotic. As the complexity of the feedback networks in the model are increased, the planet’s self-regulation becomes more stable, with an improved ability to recover from severe disturbance (Lovelock 1991).

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(e.g. electrons, gravity, etc.) (Richardson 2005). Scientific realism is premised on the argument that science has been able to successfully predict various phenomena, hence the theories they use to make these predictions must be true representations of reality (Chalmers 2002).

Popper moderated the realist view with his *conjectural realism* view of scientific progress (Popper 1979). This view addresses the problems of induction by incorporating the criteria of falsification and by recognising the fallibility of theory. Popper believed that science works through a process of critical selection and refinement, falsifying and replacing old and imperfect theories about the world, and replacing them with new and improved theories that provide a more accurate reflection of how the world *really* works. In this view, the aim of science remains that of uncovering the true nature of reality, despite the impossibility of actually doing so, given conjectural realism regards all scientific knowledge as essentially hypothetical (Chalmers 2002). This has become the dominant view of science since the demise of logical positivism (Chalmers 2002). Nonetheless, despite their differences, positivist and realist philosophies of science are both premised on the materialist assumption that there is an objective independent reality which is being progressively revealed by science. This cumulative notion of scientific progress largely prevails among scientists to this day, despite being broadly challenged by Kuhn’s (1962) revolutionary paradigm-based view of scientific progress.

Thomas Kuhn started his career as a physicist, but shifted his focus to the history and philosophy of science in the 1950s (Bird 2011). In 1969 he published his influential book *The Structure of Scientific Revolutions*. In the book, Kuhn traces the history of science and concludes that science progresses through periods of slow stable growth, punctuated by revolutionary paradigm shifts, marked by crisis before one prevailing theory is discarded and replaced by another (Chalmers 2002). According to Kuhn, the stable, ‘normal’ periods of scientific change are *qualitatively* different from the changes that take place during paradigm shifts (Bird 2011).

Kuhn rejects the idea that science precedes in a gradual progression (whether by falsification or induction) that incrementally reveals the true nature of reality. Rather, his historical view suggests that as a new, disorganised science becomes more and more organised, it eventually structures into a ‘normal science’ consisting of a single paradigm. A scientific paradigm comprises the general theoretical assumptions, laws and techniques adopted by its particular scientific community (Kuhn 1962). For example, the 19th century scientific paradigm was the Newtonian paradigm, which assumed the whole universe could be explained as mechanical system operating in accordance to Newton’s laws (Chalmers 2002). In normal science, scientific effort is focused on validating and reinforcing the existing paradigm, which Kuhn describes as puzzle-solving governed by the rules of the paradigm (Chalmers 2002; Kuhn 1962). Normal scientists therefore assume “that a paradigm provides the means for the solution of the puzzles posed within it”, and are therefore uncritical of it (Chalmers 2002, p.110). As such, observations or theories that fail to fit the dominant paradigm are often discredited or dismissed as anomalies by the normal scientific community. However, as challenging evidence ‘piles up’ and can no longer be ignored, a point of crisis is reached. This is resolved when a new paradigm develops, to which scientists increasingly defect, until the old paradigm is finally abandoned in favour of the new (Kuhn 1962).

Capra (1997) notes that of all the self-organising hypotheses developed in the 60s and 70s, the Gaia theory was to encounter the greatest resistance. In line with Kuhn’s (1962) revolutionary view of scientific progress, the Gaia hypothesis did not fit into the ‘normal’ scientific paradigm, and was therefore attacked and dismissed by ‘normal’ scientists. Although not so surprising today, the notion that life creates conditions that sustain its own existence was radical for its time when scientists believed that geological forces had independently and by chance created conditions suitable for life (Capra 1997). Unlike physicists and cybernetics, who had adjusted their paradigms of how the universe works in the wake of quantum mechanics and systems theory, biologists had been largely insulated from these fields, influenced instead by the mechanically-oriented molecular sciences (Capra 1997). In addition, biologists and most other natural scientists are strongly wedded to the Darwinian notion that evolution is neither purposeful nor subject to divine intervention; it is driven by chance only (e.g. Mayr 1999). Thus, the conceptual limits, underlying assumptions and world views of natural scientists of the time prevented them accepting
the idea of self-organisation, whereby life could create and regulate beneficial conditions for itself without an inherent purpose or goal rendered somehow by consciousness or God (Capra 1997). From their normal science perspective, theories suggesting downward causation (e.g. by a whole governing its parts) could only imply supernatural belief or flawed logic on the part of the theorist, and therefore must be rejected. Indeed, this perspective still prevails in much of society and among many natural scientists who continue to operate fully within the Newtonian paradigm of a mechanistic universe, driven only by upward causation, cause and effect (e.g. Dawkins 1986).

Thus, despite repeated assertions on the part of Margulis and Lovelock that they never proposed Gaia to be purposeful or teleological, dogmatic criticisms to this effect were widely raised, and the vitalist-mechanist debate revived (Capra 1997). Lovelock’s findings were rejected by established academic journals and remained unpublished until taken up by Carl Sagan in his *Icarus* journal (Capra 1997). Capra (1997) suggests that the ‘image’ of Gaia as a sentient being was the underlying reason for rejection of the hypotheses, and postulates that the scientific establishment’s irrational reaction may have been a simple result of the hypothesis’ name evoking a mythical goddess.

Kuhn’s work challenged long-held empirical and positivist assumptions of an objective reality which is methodically revealed through the workings of science. Rather his work shows that even scientific reality is largely a social construction (Bird 2011). By demonstrating science’s susceptibility to social and cultural influences, Kuhn’s ideas have been widely used by postmodern thinkers to dispute the supposed objectivity of science.

A1.6.5 *Postmodern Philosophy*

Postmodern thought gained popularity in the 1960s, and came to have a strong influence in a variety of disciplines—including art, philosophy, economics, politics, and sociology—in the decades that followed. According to Glover (2006) postmodern philosophy arose as a reaction to the perceived failures of modern industrial society, and rejected positivistic and scientific assumptions that there is a single objective reality, and materialist notions that ‘truth’ can be revealed by science. Cilliers (1998) suggests that modern thinking constitutes an “avoidance of complexity” (p.112), in its “obsession to find one essential truth” (p.112). Postmodern philosophy, in contrast, has its roots in the idealist thinking of Kant, who argued we cannot truly know things, as our experiences of them are shaped by our minds (McCormick 2005). As such, postmodern views are commonly premised on the understanding that different people and different groups derive different perspectives on reality and truth, as they attempt to draw meaning from their experiences and make sense of their environment (Stroh 2004). Because all people exist within unique local circumstances, it is therefore impossible to unify the complexity of their accounts of the world into a single description of reality—i.e. a grand or metanarrative27 (Lyotard 1984). As such, many postmodernists reject materialist notions that there is an single objective reality that shapes us and our behaviours—i.e. they reject metanarratives28. Jashapara (2004) notes that some postmodernists argue that reality is socially constructed (e.g. Shotter 1994), because the so called ‘common sense’ sense facts about reality that people take for granted can actually be viewed and understood very differently, particularly by those of another culture. As such, we extract our ideas and beliefs about the world through a process of discourse with others, using language and communication (Shotter 1994). Thus, from the postmodern perspective reality is comprised of a multiplicity of co-existing subjective discourses (Cilliers 1998).

Foucault (1980) links discourse with power and ideology, arguing that power works through discourse to shape beliefs and attitudes. As such, expert discourse becomes a means of restricting

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27 Lyotard (1984) argues that because electronic media pervasively bombards people with a diversity of external ideas and values, we can no longer explain behaviour or progress in society in terms of the personal histories and experiences of its individuals; i.e. grand (or meta) narratives can no longer explain society or its history. From this, Lyotard concludes that it is not possible to assume that knowledge is created for its sake, or that knowledge is produced as people search for emancipation. Baudrillard (1988) extends the argument, stating that electronic media have severed our ties with the past. As such, the Marxists’ materialist notion that society is a product of history and economics is no longer true: electronic media is now the force that shapes society (Baudrillard 1988). From this argument, Stroh (2004) surmises that there is no longer a dominant ideology, just a world satiated with a multitude of paradoxical views and assumptions.

28 Paradoxically, however, this then means that postmodernity is a metanarrative of ‘no metanarrative’ (Glover 2006).
alternative discourse and ways of thinking. Powerful, vested interests attempt to dominate discourse by controlling knowledge through technologies that enable surveillance, enforcement and discipline (Foucault 1980).

Postmodern thinking in the management field emerged as a critical reaction to industrial business practices rooted in the mechanistic paradigm associated with Taylor’s scientific management (see Appendix 4, Section A4.3). This has resulted in a more organic conception of organisations as being subject to the natural forces of evolution and transformation, a view that has since taken over from mechanistic approaches to management theory (Stroh 2004).

Postmodernism is a ‘meta-theory’, in that it comprises a somewhat bewildering variety of often-conflicting theories and practices, from a range of disciplines (Stroh 2004). Because postmodern thinking challenges and resists generalising assumptions, frameworks and paradigms, it has been criticised as being too complex and ambiguous, and as preventing the establishment of general theories that can help understand and improve the social world (Jashapara 2004). It has also been criticised for being self-referential (Habermas 1987) and for adding nothing to empirical knowledge (Chomsky 1995). As such, Jashapara (2004) notes that critics argue postmodernism is losing influence in the 21st century world.

A1.6.6 Emergent Spacetime – Today’s Holy Grail

Meanwhile, in the 80 years since the formulation of quantum mechanics and against the backdrop of WWII, the post-war period, and the postmodern era, theoretical physicists have been pursuing their holy grail: quantum spacetime, the theory that will unify all physics (Smolin 2002).

The notion of whether or not spacetime (i.e. gravity) has an independent existence have been debated since Newton proposed his theories of absolute space and time and was countered by Leibniz’s relationalist views (see Section A1.3.4). The debate largely ended with Einstein’s general theory of relativity, which purported that while spacetime/gravity is ‘real’, it is a dynamical structure that interacts with matter, rather than an inert backdrop in the Newtonian sense. While Einstein’s general theory of relativity explains space and time, quantum theory explains everything else in the universe (e.g. elementary particles, atoms, chemistry) (Smolin 2003). However, problems arise when physicists attempt to incorporate relativistic gravity with quantum effects, because in doing so, spacetime appears to dissolve (Wuthrich 2010). As such, physicists have been working on a number of competing theories of quantum spacetime (also referred to as quantum gravity) to resolve this problem, including string theory, co-variant quantum gravity and loop quantum gravity.

Within all these theories, spacetime is viewed not as an ingredient of the universe, or some ‘thing’ in which the universe is situated, but rather as a higher order phenomena that somehow emerges from a deeper reality that is not spatial or temporal (Wuthrich 2010). This idea, that at a basic level space and time are not ‘real’, shatters our understanding of the universe and our idea of physical existence (Wuthrich 2010). As such, some theoretical physicists, such as Lee Smolin (2008) and Carlo Rovelli (2012), are calling for science to reconsider its long-standing divorce with metaphysics (precipitated by the pre-WWII logical positivists) in aid of addressing “the deep philosophical and foundational issues in physics” (Smolin & Harnad 2008, p.290).

A1.7 Summary & Conclusion

According to Capra (1997), the history of western science is characterised by a tension and competition between the study of substance (what is it made of?) and the study of form (what is its pattern?). This appendix shows selected aspects of the co-evolution of Western philosophy, science and mathematics, and how it has been shaped by the cyclical emergence and subsidence of opposing theories about the nature of reality: mind vs. matter, materialism vs. idealism, form vs. substance, determinism vs. free will, upward vs. downward causation, whole vs. parts, quantity vs. quality, and order vs. chaos. For example, the idea of matter being atomic was first devised by ancient Greek philosophers, shot down by Socratic philosophers, briefly revived by the Epicureans, then, two thousand years later, taken up in the scientific theories of Galileo and Newton. For centuries afterwards, the worldview underlying science was largely materialist and Newtonian, with corresponding philosophies of reductionism, mechanism and modernism (Heylighen al. 2007).
Appendix 1

Ontologically, this worldview reduced everything to movements of independent material particles governed by deterministic laws (i.e., atomism). Epistemologically it held the promise of complete, objective and certain knowledge of past and future (Heylighen et al. 2007). The Newtonian focus on ‘being’, substance and order led to the creation of the scientific method and revolutionised the world.

The importance placed on the role of pattern, organising relations and emergence in shaping reality has likewise emerged and subsided through history. These ideas were postulated by the Pythagoreans of 500 BC, fell away during Socratic times, and then were revived by German idealist philosophers of the 18th century. They were later ‘proved’ by mathematical logicians of the 19th and early 20th centuries (as detailed in Appendix 2), and taken up by organicist biologists, holists, process philosophers and quantum physicists of the early 20th century. Logical positivism then arose to banish notions of pattern and emergence from science and philosophy, just as WWII erupted and scattered Europe’s intellectual cauldron of great thinkers. Post-war molecular biologists and natural scientists continued to dismiss and neglect such notions in favour of reductionism. Meanwhile, as the century progressed, notions of a self-organising emergent reality were revived once more by postmodernist thinking in the social sciences and by the quest for emergent spacetime in the world of physics. They were also independently ‘discovered’ by chaos and complexity scientists working in the fields of mathematics and evolutionary biology in the latter stages of the century.

Nobel Prize laureate Ilya Prigogine states that astonishing success of science has led to a “collision between what has often been called the ‘two cultures,’ science and the humanities,” and has led to the repeated question, “How to choose?” (Prigogine & Stengers 1984, p.11). However, according to Alfred Whitehead, a clash of doctrines is an opportunity, not a disaster (Prigogine & Stengers 1984). In ancient times, Heraclitus purported that all entities come into being through a tension between opposing properties. This view suggests the competing themes that repeatedly emerge, subside and remerge in Western metaphysics aren’t actually conflicting. Rather, they are elements of a singular, higher-order phenomena, just as Newton’s absolute space and time were revealed as unified in the fourth dimension by Einstein (Figure A1.1). In the appendices that follow, mathematical logic is used to ‘prove’ this paradoxical idea (Appendix 2), and concepts from the sciences of complexity and chaos are used to help us understand how this is so (Appendix 3).


Appendix 1


Appendix 1


Appendix 1


Ridling, Z. (2001). Philosophy Then and Now: A look back at 16 centuries of ideas that have shaped our thinking


Appendix 1


APPENDIX 2

A MATHEMATICAL PERSPECTIVE: LOGIC THEORIES
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Appendix 2

A MATHEMATICAL PERSPECTIVE: LOGIC THEORIES

“The problems we have created in the world today will not be solved by the level of thinking that created them.”

—Albert Einstein (1946)

A2.1 Introduction

A fundamental premise underlying this study is Heraclitus’ ancient notion that all entities come into being through a tension between opposing properties, that opposites, though different, are nonetheless interconnected. The discussion in Appendix 1 illustrates how this metaphysical thread has woven in and out of Western science and philosophy throughout history. Nonetheless, for most contemporary Western minds, Heraclitus’ ideas are paradoxical and counterintuitive.

One way in which paradox1 can be resolved is through the application of mathematical logic. Mathematical logic is concerned with formal logic and proof systems and serves to increase precision in reasoning. It has been applied to numerous fields, including: philosophy, cybernetics, computer sciences, linguistics, neuroscience, psychology and the complexity sciences. This short appendix contains a selection of three logic theories relevant to the body of this thesis: Group Theory, the Theory of Logical Types, and Godel’s Incompleteness Theorem.

A2.2 Group Theory

In the 1800s, mathematicians were recognising logical inconsistencies and gaps in their trade. They began applying formal logic to prove the consistency of mathematical foundations and to develop axiomatic frameworks for geometry, arithmetic and analysis (Irvine 2010). In the early part of the century, the young mathematician Evariste Galois, in a frantic evening whilst under threat of death in a sunrise duel (he was killed), wrote Group Theory (Watzlawick et al. 2011). Group Theory is a mathematical framework for thinking about change among members within a class or group, and explains the interdependence between persistence and change (Watzlawick et al. 2011). Watzlawick et al. (2011) note that groupings are the most basic element of human perception, in that they give structure to what would otherwise seem a chaotic environment. The authors also provide detail of how the properties outlined by Galois’ Group Theory demonstrate the “peculiar interdependence between persistence and change” in groups (p.7).

According to Watzlawick et al. (2011), Galois’ Group Theory, very coarsely interpreted, postulates that a group has four properties:

1. It is composed of members that all share one common characteristic; members can be numbers, objects, concepts, etc., as long as the outcome of combining any members of the group is itself a member of the group.
2. Its members can be combined in any sequence, and the outcome will be the same.
3. A group contains an identity member, which when combined with any other member gives that other member, i.e. the other member maintains its identity.
4. Every member in the group has an opposite, and when the two are combined, they give the identity member.

For example, in relation to the first property, Watzlawick et al. (2011) provide the example of members of a group consisting of the numbers 1-12, indicating the hours on a clock. If 12:00pm is combined with 6 hours, the result is 6:00pm, or if combined with 12 hours the result is 12am; both results, 6pm and 12am, are themselves group members. Thus, when members of the group are combined, the result is a change from one internal state of the group to another; however, the overall group itself is unchanged. Ordering things into groups establishes invariance, such that any

1 According to Slater (2005) “a paradox is generally a puzzling conclusion we seem to be driven towards by our reasoning, but which is highly counterintuitive, nevertheless.”
Appendix 2

A combination of members results in yet another group member—i.e. the result will never be a member that does not fit inside the group; the result is always a member that shares the common group characteristic.

In relation to the second property, Watzlawick et al. provide the example of a group which contains a number of position moves on a surface, each one of having a particular length and direction. No matter how these moves are combined, one will always end up in the same final position. The simplest case would be one where the group consists of four moves, each of the same length, in each of the four cardinal directions, north, south, east and west. No matter how these moves are combined, one will always end up in the same position—in this case where one started (try it on a piece of paper, then try it with a group consisting of moves of different length and direction). Thus there is “changeability in process, but invariance in outcome” (p.7). No matter how the group is reorganised, the final outcome is always the same.

For the third property, Watzlawick et al. illustrate as follows. When the combination rule for a group is additive, the group’s identity member is 0. For example, 5+0=5. When the given member (5) is combined with the identity member (0), the result is the given member (5). If the group’s combination rule is multiplication, however, then the identity member is 1, for example 5×1=5. Another example is a group whose common characteristic (i.e. invariant property) is sound. The identity member for this group would be silence—when a sound is combined with silence, the outcome is sound. If the group’s common characteristic is motion, then the identity member would be immobility. Although the notion of an identity member seems pointless, it is a special case of group invariance that serves an important ‘null function’ in maintaining group stability. The point here is that however a group’s identity member acts or combines with other group members, it makes no difference to the final outcome, the relevance of which is demonstrated in the next example.

Finally, with respect to the fourth property, Watzlawick et al. again use the example of a group where the combination rule is additive. If you take group member 5, combine it with its opposite -5, the result is 0, which is the group’s identity number: 5+(-5)=0. Thus, although combining a group member with its opposite constitutes a large change, that change results in the group’s identity member, which has no effect on the final outcome.

These examples demonstrate how marked changes taking place within the group do not cause any change in the overall group itself. When a system runs through all its possible internal states without effecting an overall systemic change, it has become caught in a Game Without End: the system cannot generate from within the rules needed to change its own rules (Watzlawick et al. 2011). Deadlocks are another result of trying to effect change from within a system. The theory also relates to circular negative feedback systems that maintain system stability in cybernetic and homeostatic processes.

Thus Watzlawick et al. evoke Galois’ Group Theory to explain the paradoxical relationship between persistence and change; why, despite their apparent opposing natures, they must occur together. As such, Galois’s Group Theory resolves the paradox of Heraclitus’ unity of opposites, and the Pythagorean notion of reality coming forth through the interplay of ‘being’ and ‘not being’, a concept later built on by Hegel in the Romantic era. All perception is necessarily relative, a matter of contrast and comparison—nothing can exist without its opposite. If everything in the universe is blue, it is not possible to have a concept of ‘blueness’ (Watzlawick et al. 2011). Likewise, if there is no sleeping it is not possible to have a concept of being awake; if there is no noise, there can be no silence. This notion relates to the Zen koan, which asks, “What is the sound of one hand clapping?” Watzlawick et al. (2011) posit that although many theories of change and persistence have been formulated in Western culture, in the last centuries most of these have been about either change or persistence, not the interrelationship between the two.

A2-2
A2.3 Theory of Logical Types

Between 1910 and 1927, Alfred Whitehead and his student Bertrand Russell published the seminal *Principia Mathematica* (Whitehead & Russell 1913), an attempt to build a logically consistent set theory on which to found all mathematics. Their book is possibly the most important contribution to logic and philosophy since Aristotle, and one of the 20th century's greatest scientific documents (Irvine 2010). Not only did *Principia Mathematica* demonstrate the deductive power of logic, it also re-established the links between logic and metaphysics and epistemology, and influenced a wide range of fields from math and philosophy to computer science, linguistics and psychology (Irvine 2010). Much of the book is dedicated to resolving Russell’s Paradox, a contradiction Russell discovered in set theory whilst working on the book (Clement 2005).

Paradoxes have long baffled Western thinkers. A classic example, which is related to Russell’s paradox, is the ancient Epimenides paradox whereby a Cretan gives the warning that “all Cretans are liars.” If the statement is true, it is false; if it is false, it is true (Watzlawick *et al.* 2011). In self-referentially asserting its own falseness, the sentence creates a paradox. Such statements are not provable and create a circular confusion in the minds of those who encounter them. In *Principia Mathematica*, Russell and Whitehead introduce their Theory of Logical Types, which they devised to rule out self-reference in logic and prevent emergence of paradox (specifically Russell’s Paradox).

The theory starts with the idea of a collection consisting of ‘things’ united by a common characteristic (i.e., a group). As did Galois, Whitehead and Russell use the term ‘member’, to refer to the individual ‘things’ making up a collection. However they use the term ‘class’, rather than ‘group’, to refer to the total collection of members. According to the theory, “whatever involves all of a collection must not be one of the collection,” as they are of different logical types, or levels (Watzlawick 2011, p.8).

Watzlawick *et al.* (2011) illustrate the notion of logical types/levels using the concept of ‘humankind’. Humankind is the class of all human individuals, but is not itself an individual human, i.e. they are different logical types. As such, any attempt to deal with one in terms of the other, i.e. confusing logical types, will lead to “nonsense and confusion” (p.8). An example of a situation where logical levels are confused would be assuming that the economic behaviour of a large city can be explained by taking the economic behaviour of one of its inhabitants and multiplying it by the city’s population (the so-called Robinson Crusoe economic model). The critical distinction here is that a city of four million is not just quantitatively different from an individual, it is qualitatively different; i.e. a class is qualitatively different from its members (Watzlawick *et al.* 2011). Errors in logical typing normally occur either because a particular property has been incorrectly ascribed to a class instead of a member (or vice-versa), or by treating class and member as if they were on the same level of abstraction (Watzlawick *et al.* 2011). Such errors result in paradox and vicious circles (see Appendix 4, Section A4.4.3).

Watzlawick *et al.* (2011) suggest that we are universally faced with hierarchies of logical levels created by classes and their members, and that our frequent confusion of logical levels leads to ever-present “puzzling consequences” (p.9). They note that the phenomenon of change is subject to this principle, be it in physics or in human behaviour. Specifically, they refer to Bateson (2000), who illustrates that a class cannot be understood in the language of its members, that rather a new metalanguage is required. Bateson starts by thinking about the notion of *position*. Position is described using the framework of space and understood mathematically as a point corresponding to coordinates on an $x, y, z$ axis. He then introduces the idea of a change in *position*. However, in order to talk about or understand a change in position, one must step outside the theoretical framework of *position*. This is because the idea of a changing position cannot be generated using the language or computations (i.e. coordinates on an $x, y, z$ axis) of position. Rather the dimension of *time* must be introduced and with it a whole new language (motion, velocity) and computational framework is needed (e.g. calculus). In other words, shifting one’s thought from the notion of position to that of a change in position requires a *jump* to higher logical level. A change in motion, being a change in a change of position, is a *meta-change*, and introduces more new language (acceleration, deceleration) and computations. A change in acceleration is a meta-meta change, and again, requires a new
framework for its description (one which created enormous theoretical challenges for space scientists). Thus, attempting to deal with change in position (motion) within the framework of position, or a change in motion (acceleration/deceleration) within the framework of motion, violates the axiom of the Theory Logical Types and leads to paradoxical confusion (Bateson 2000; Watzlawick et al. 2011).

Thus, a new language and computational framework is required for describing phenomena at each logical level. Explorations into quantum physics were only opened up by the invention of a new mathematical language incorporating the concept of operators, as classical formulations for explaining macroscopic phenomena cannot be applied at the quantum level (Prigogine & Stengers 1984).

The hierarchy of logical types can also be thought of in direct relation to Einstein’s notion of four-dimensional spacetime. For example, the intersection of latitude and longitude, two independent coordinates, specify a unique position, or point, on the earth’s two-dimensional surface. Add depth, or height, and objects can be specified in that three-dimensional space. Then add time, and an event is now specified in four-dimensional spacetime. Each shift to a higher dimension requires the introduction of a qualitatively new concept (first space, then time), and therefore a jump to a higher logical level.

If we make an error in logical typing when attempting to explain phenomena, paradoxes are generated. For example, by treating space and time as absolute and unrelated (see Figure A1.1 in Appendix 1), Newton’s theory of universal theory of gravitation generated the paradox of instantaneous gravitational force. This paradox was finally resolved when Einstein unified space and time into a curved four-dimensional spacetime, thereby assigning it a higher logical order. The paradoxical nature of Whitehead and Russell’s theory is also exemplified by the standard metre in Paris: it is the one item in the world that cannot be measured using the metric system, because it is the basis of the entire metric system (Watzlawick et al. 2011).

Watzlawick et al. (2011) also provide language-based examples that illustrate this theory. There are many different things expressed in a language, but in order to talk about the language itself, linguists have had to invent a metalanguage, which also needs a meta-meta language to discuss its structure. Another example is methodology, the philosophical study of the methods used in different disciplines, which is of a higher logical type than method, and therefore a meta-method. Watzlawick et al. note that our language often creates confusion in failing to discern between logical types, and thereby assigning the same names to things that are of different logical levels.

The Theory of Logical Types resolves the ‘all Cretans are liars’ paradox by asserting that the Cretan who calls other Cretans liars cannot be included in the class of other Cretans in this context. By making a statement concerning the whole of a group of people, he cannot be of that group of people; therefore statements he makes about the group cannot be applied to him (Grof 1981).

Watzlawick et al. (2011) sum up by drawing two key conclusions from the Theory of Logical Types: 1) to prevent paradox and confusion logical levels must be strictly separated; and 2) moving between logical levels involves a discontinuous ‘jump’ of some sort, a transformation. This jump is of practical importance as it provides a route out of the system.

A2.4 Godel’s Incompleteness Theorem

In 1931, Kurt Godel, a member of the Vienna Circle, and widely regarded as the most important (and maddest) logician in modern times (Hawking 2007), used Principia Mathematica as a basis to devise his Incompleteness Theorem (Watzlawick et al. 2011). His theorem established the essential limitations of the axioms of arithmetic, by showing that within a formal arithmetic system there is

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2 The paradox of instantaneous gravitational force requires information to travel faster than the speed of light in order to allow masses to respond to changes in gravitational field.
always a statement, which although apparently true, cannot be proven within the system\(^3\) (Hawking 2007). As such, no system can prove its consistency within its own framework:

Proof can only come from outside, based on additional axioms, premises, concepts, comparisons, etc., that the original system cannot generate or prove, and which themselves are only provable by recourse to yet a wider framework, and so on and so on in an infinite regress of metasystems, metametasyncystems, etc. (Watzlawick \textit{et al.} 2011, p.24).

This complements the Theory of Logical Types, which says that any statement about a collection involves all the collection, and must therefore not be a part of it (Watzlawick \textit{et al.} 2011, p.24). Metaphors for Godel's Incompleteness theorem include trying to figure out for yourself whether or not you are insane, or trying to see your own face with your eyes (Denton 2012).

\textbf{A2.5 Summary & Conclusion}

Galois’s Group Theory unravels Heraclitus’ ancient paradox of the unity of opposites, demonstrating how it is that change within a system does not change the overall system itself, and rather reinforces the system whole it instead. The Theory of Logical Types demonstrates how system wholes are qualitatively (logically) different from their parts, and how paradox is generated when logical levels of phenomena are confused.

While Group Theory is a way of thinking about change that occurs within invariant systems, the Theory of Logical Types is a way of thinking about the “peculiar metamorphosis” that occurs when one \textit{jumps} from one logical level to another, escaping one invariant system to enter another (Watzlawick \textit{et al.} 2011, p.11). This relates to Godel's Incompleteness Theorem, which demonstrates that logical systems always contain a ‘hole’, or a piece of missing information (Briggs \& Peat 1989). It is this ‘hole’ which creates the requirement for a qualitative ‘jump’ when moving from logical level or type to another. The critical importance of this notion will become apparent in \textbf{Appendix 3}, as we explore the mysterious and paradoxical worlds of chaos and complexity.

\footnote{3 For example, any statements that assert their own falseness are not provable within their own framework, such as the all Cretans are liars' paradox, which can only be proven if the Cretan who speaks the statement is not classed as a Cretan.}
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APPENDIX 3

COMPLEXITY PERSPECTIVE: CHAOS, SELF-ORGANISATION & COMPLEX ADAPTIVE SYSTEMS


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“Unfortunately, non-chaotic systems are very nearly as scarce as hen’s teeth, despite the fact that our physical understanding of nature is largely based on their study...Algorithmic complexity theory and non-linear dynamics together establish the fact that determinism reigns only over a quite finite domain; outside this small haven of order lies a largely uncharted, vast wasteland of chaos.”
—Ford (1983, in Sheldrake)

“The 21st century will be the century of complexity”
—Stephen Hawking

A3.1 Introduction

In the 1920s, discoveries in the field of quantum mechanics demonstrated the profound interconnectivity of the universe, reviving interest in the holistic philosophies of Kant and Goethe. As outlined in Appendix 1, this notion of metaphysical wholeness became a centrepiece of Whitehead’s process philosophy, Smut’s holism, Alexander’s emergentism, and von Bertalanffy’s general system theory. It was also reflected in the holistic notions of the organicism movement and early ecologists (Capra 1997). However, by the time the dust of WWII had settled, these theories, with their panpsychic and idealist leanings, were lost to mainstream science, having succumbed to the purges of the logical positivists and their remnants swallowed by war. Newtonian reductionism made its forceful revival in the scientific realism that came to dominate scientific thinking of the post-war era.

Yet despite its spectacular successes, reductionist science, which breaks everything down into its simpler parts, leaves a vacuum in its lop-sidedness:

How do we use the information gleaned from the parts to build up a theory of the whole?
The deep difficulty here lies in the fact that the complex whole may exhibit properties that are not readily explained by understanding the parts. (Kauffman 1995, p.vii-viii)

The origin of these inexplicable properties constitutes the ‘hole’ or ‘missing information’ in the reductionist system of thought, and therefore cannot be understood within the framework of reductionism, as per Godel’s Incompleteness Theorem (Appendix 2). Nature abhors a vacuum, of course, and a radically new conception of the ‘whole’ was needed to fill this ‘hole’ in Newtonian reductionism. As touched on in Appendix 1, investigations into complex, self-organising systems in the late 1960s began with the formulation of non-linear mathematics and the advent of high-speed computers. This led to the construction of mathematical frameworks describing the behavior of dynamic non-linear systems in the newly emerging chaos and complexity sciences. The mathematical frameworks that describe the behavior of iterating and self-organising non-linear systems (i.e. complex systems) are variously referred to as chaos theory, complexity theory, dynamical systems theory, systems dynamics, and non-linear dynamics (Capra 1997).

As the Theory of Logical Types and Godel’s Incompleteness Theorem imply, because chaos and complexity theories relate to phenomena of a higher logical order than that which can be explained by the Newtonian paradigm, they require an entirely new set of premises, and a profoundly different way of thinking about reality. This new and radical way of understanding the world will be illustrated in this appendix by drawing on the works of Prigogine and Stengers (1984), Briggs and Peat (1989), Capra (1997, 2010), Maturana and Varela (1980, 1992), Kauffman (1993) and Holland (1995), in an exploration of the following topics referred to in the body of this thesis:
Appendix 3

- Non-linear mathematics
- Dissipative structures
- Autopoiesis
- Chaos Theory
- Complex self-organising systems
- Complex adaptive systems

A3.2 The Rise of Complexity

A3.2.1 Poincare Discovers Chaos

In order to understand the origins of the complexity-thinking that emerged out of post-war systems-thinking (as detailed in Appendix 1), it is necessary to take a long step back to 1887, when a major advance was made in the field of non-linear mechanics by the French polymath Henri Poincare. While Newton’s linear equations had enabled scientists and engineers to relate rates of change to various forces and to create the technological marvels of the fledging industrial age, they were unable to explain non-linear phenomena, such as explosions, high winds, and sudden breaks in materials (Briggs & Peat 1989). Non-linear behaviour was poorly understood, and even the simplest non-linear equations of the time were too difficult to solve in most cases (Briggs & Peat 1989). Natural non-linear phenomena, such as air or water turbulence, were viewed as too chaotic and were generally avoided by scientists (Capra 1997). When confronted with non-linear problems, engineers would ‘linearize’ them, replacing them with linear approximations, a type of differential equation that served to hide system complexities. Application of linear approximations became so habitual that many engineers and scientists came to believe that most natural phenomena behaved in linear ways—i.e. simply and predictably (Capra 1997)—despite most natural systems and all living systems being “relentlessly non-linear” and complex in reality (Stewart 1989, quoted in Capra 1997, p.122). This view, which reinforced reductionism and denied complexity, took hold in the in 1900s and persisted for most of the 20th century (Capra 1997).

This leads to the subject of Poincare’s discovery. In the 1600s, the focus of mathematics had swung from the more qualitative image-based geometry, to quantitative analysis via formula-based algebra (Capra 1997). Whereas solutions from linear equations can be generalized to other problems, this is not the case with non-linear equations, which tend to be peculiar (Briggs & Peat 1989). As such, non-linear systems are better suited to qualitative (descriptive), rather than quantitative (numerical) analysis. In the late 1800s, Poincare devised topology as a way of analysing the qualitative features of non-linear problems. Topology (otherwise known as rubbersheet geometry) is a geometry whereby lengths, angles, areas, etc. can be continuously distorted such that they transform into different shapes (Capra 1997); as such, it is the study of continuity and connectivity. Briggs and Peat (1989) describe how topologically equivalent figures can be distorted into each other. For example, a triangle can be distorted into a rectangle, the rectangle into an octagon, then octagon into a circle. These figures are topologically equivalent. Likewise, a pyramid can be distorted into a cylinder; therefore the two are topologically equivalent. However, a square cannot be distorted into a cube; as such they are not topological equivalents. Topology discerns those properties that are not changed when a figure is distorted. For example, when a square is distorted into a circle, it remains two-dimensional. When a cube is distorted into a cylinder it remains three-dimensional. The holes in a shape are also invariant – a ball can never be transformed into a donut and vice versa (Briggs & Peat 1989). It these invariant properties (or patterns) that prevent topological non-equivalents from transforming into each other; thus topology is a mathematics of “relationships, of unchangeable, or ‘invariant’ patterns” (Capra 1997, p.126).

Poincare was interested in the workings of Newtonian mechanics in closed systems. At the time, closed systems in physics were regarded as perfectly orderly and predictable, as per the Newtonian model of the universe (Capra 1997). Any unpredictable, random and chaotic behaviour in observed systems (e.g. a pendulum swinging in a vacuum) was attributed to disturbance or ‘contamination’ from unforeseen outside forces, therefore indicating the system was not perfectly closed. Using Newton’s laws, physicists were able to exactly predict the effects of two celestial bodies interacting
A3.2.2 From Linear to Non-linear Mathematics

Despite making strides in management, engineering and cognitive sciences, by the 1970s systems thinking (see Appendix 1, Section A1.6.1) was either ignored or viewed as a failure by mainstream sciences. According to Lilienfied “No evidence that systems theory has been used to achieve the solution of any substantive problem in any field whatsoever has appeared” (1978, quoted in Capra 1997, p.78). Capra (1997) attributes this view to the fact that General Systems Theory had not been developed into a mathematical discipline. Mathematics of the time was still largely limited to linear equations that were unable to describe complex, non-linear phenomena (i.e. most of nature). Indeed, engineers and mathematicians had been masking complex phenomena for decades via the use of linear approximations (Capra 1997).

Briggs and Peat (1989) describe non-linear equations as a ‘mathematical twilight zone’: “Solvers making their way through an apparently normal mathematical landscape can suddenly find themselves in an alternate reality” (p.23). Unlike linear equations, where small changes lead to small effects and vice versa, in simple non-linear equations one small change has the potential to generate huge, sometimes catastrophic changes, thanks to the wonders of feedback (Briggs & Peat 1989). A key feature of non-linear equations is that they incorporate feedback, meaning A causes B, then B has an effect on A. This creates a feedback loop, which is a form of iteration, whereby the system repeatedly works back on itself (Capra 1997). Iteration and negative feedback (whereby B’s effect is to limit A) can stabilize a system, whereas iteration and positive feedback (whereby B’s effect is to amplify A) can cause a system to ‘run away’, as in the case of explosions. Iteration is typical of non-linear systems, and is responsible for the rich complexity often seen within them. It also makes a system inherently unpredictable, even in the case of strictly deterministic equations (where all the rules and variables remain constant) (Briggs & Peat 1989). A non-linear system can exhibit a constant pattern of behavior for long periods, then suddenly, at a critical point, change its behavior altogether or devolve into seemingly random, chaotic behavior. Non-linear equations are too complex to be solved using analytic methods (manipulating an equation until you get a final solution). Instead numerical methods are required, involving lengthy trial-and-error to find a combination of variable numbers that ‘fits’ the equation (Briggs & Peat 1989). Resolving such problems by hand or with early computers was impossible.

In the 1960s, Poincare’s topological system had been revived as a way of visualising non-linear systems that were too difficult to describe using mathematical computations and non-linear equations. Mathematicians learned they could bend and twist topological shapes to represent how a system moves or behaves. Early chaos theorists began using topology to map the behaviour of
non-linear phenomena and in doing so caught some of science’s first glimpses of strange attractors, the patterns of implicit order that emerge when non-linear systems become chaotic (Briggs & Peat 1989). Interest in non-linear phenomena began to mount as scientists in the 1960s and 70s began looking at self-organising behaviour of systems far from thermodynamic equilibrium, then accelerated in the 1980s with the advent of high-speed computers (Capra 1997). Models of self-organising systems requiring computation of thousands of inter-dependent feedback interactions were finally made possible by the use of non-linear mathematics and powerful computers in the 70s and 80s. The examination of non-linear systems was no longer relegated to the ‘too-hard basket’, and a new voyage of mathematical discovery was launched, almost a century after Poincare’s overlooked mathematical forays into the non-linear world (Capra 1997). According to Capra (1997), the discovery of non-linear mathematics is possibly one of the most important events of the 20th century. It launched numerous fields of study, including non-linear thermodynamics, autopoiesis, chaos theory and complexity theory, which are discussed below.

A3.1 Dissipative Structures & Non-linear Thermodynamics

The first and most influential description of self-organising systems was that of chemist, physicist and Nobel Laureate, Ilya Prigogine’s dissipative systems. Driven by an early intuition that life’s order might somehow spring from friction and energy, Prigogine began studying non-equilibrium thermodynamics, which was a very small field at the time. It took a long time for his understanding to break through, as he was, in his words “a prisoner of the linear non-equilibrium theory”, looking at systems modelled using linear approximations (quoted in Briggs and Peat 1989, p.139). Then, in the 1960s, Prigogine made the critical discovery that systems far from equilibrium (i.e. all living systems) must be described with non-linear equations (Briggs & Peat 1989).

In order to understand the nature of living systems, he turned to simpler physical phenomena that self-organise in conditions far from equilibrium: the Benard instabilities of heat convection. Benard instabilities are strangely ordered patterns that emerge when a thin layer of liquid is uniformly heated from below. Prigogine & Stengers (1984) describe their formation as follows. As the liquid is heated, heat travels up via conduction, or flux (the heat moves up but the liquid molecules stay mostly still). This is a near equilibrium situation. However, as the liquid is further heated, and temperature difference between the upper and lower layers of liquid grows, the system moves far from equilibrium. Gravity pulls harder on the upper layer, which is cooler and therefore denser. The fluid begins to move in increasingly turbulent whorls and vortices, as cooler parts of the fluid sink and warmer parts rise. At this point, the system is chaotically dissipating heat through both conduction and through the movement of fluid molecules. Once the temperature difference between the top and the bottom of the liquid reaches a threshold value, the system arrives at a critical point of instability. At this point, a stable pattern of hexagonal pattern cells, known as Benard cells, spontaneously forms in the liquid. This signals the point where the system abandons heat conduction in favour of orderly convection, whereby heat is dissipated via coherent motion of the liquid’s molecules. The hexagonal pattern is created as hot liquid moves up the centre of the Barnard cells, and cooler liquid descends down the cell walls to the bottom (Capra 1997). If one continues to turn to the heat up, however, the hexagonal cells dissolve back into turbulent chaos. Prigogine and Stengers (1984) describe Benard cells as a “spectacular phenomenon” whereby millions of molecules suddenly begin moving together in a coherent pattern.

Thus, by moving the system far from equilibrium (e.g. by heating it up, in the case of Benard cells) to the point that it becomes turbulent, or chaotic, a spontaneous order forms via self-organisation. Prigogine described such structures as dissipative structures because they paradoxically create structure and order while dissipating energy (Prigogine & Stengers 1984). As the flow of energy and matter is increased through a dissipative structure, amplification through the formation of positive feedback loops causes the critical instability (turbulence) which the leads to the system jumping to a new form or level of organisation (Capra 1997). Prigogine’s work indicates that not only do dissipative structures maintain themselves in stable states far from equilibrium, they also evolve. As energy and matter flows increase through their structures, they may go through additional points of instability and transform into new, more complex structures (Capra 1997). As such, dissipative structures give rise to irreversible processes (Prigogine & Stengers 1984). Other examples of self-
organisation in non-living systems moved far from equilibrium include ‘chemical clocks’, lasers and cyclones (Briggs & Peat 1989).

Through his work Prigogine developed the important field non-linear thermodynamics to describe phenomena that lead to self-organisation (i.e. increased order) in open systems far from equilibrium. This is in contrast to classical thermodynamics, which describes the inevitable loss of order/organisation in closed systems close to equilibrium. In classical thermodynamics energy dissipation results in disorder and is considered waste. In non-linear thermodynamics dissipated energy creates order (Capra 1997). Prigogine also developed a new understanding of the term ‘chaos’. Traditionally in science the term was used to describe the “passive chaos of equilibrium and maximum entropy, where elements are so intimately mixed that no organization exists” (Briggs & Peat 1989, p.136), what Prigogine calls equilibrium thermal chaos. Prigogine brought into parlance the far-from-equilibrium turbulent chaos, which is hot, active and energetic (Briggs & Peat 1989), an active rather than passive dissipation of organization.

A3.2 Autopoiesis

In the 1950s, the biologist Humbert Maturana worked with cyberneticists, who lent him a strong interest in understanding system organisation. In the 1960s, while working as a neurologist, he combined his interest in understanding the ‘organisation of the living’ with his questions around what is happening during the phenomena of perception (Maturana & Varela 1980). In the 1970s, he joined forces with his student Francisco Varela to formalise his ideas into the concept of autopoiesis1 to describe the self-organising nature of living systems.

A3.2.1 Circular Organisation as the Basis of Life

Autopoiesis is premised on the notion that entities are actually units of interaction, as opposed to ‘things’ (Maturana & Varela 1980, p.8). In other words, the organisation of a living system is an abstract description of the relationships that characterise the system as belonging to a certain class (e.g. bacteria, brain, plant) (Capra 1997). Therefore, a living system, an organism, is a unit of interactions. The organism cannot be understood independently of its niche, which is viewed as the set of interactions into which it may enter. Conversely, nor can the organism’s niche be understood independently of it. Likewise, the organism’s environment is not comprised of things; rather it also consists of interactions, and is observer dependent. As such, an organism’s environment consists of the intersecting interactions between the observer, the organism, and organism’s niche (Maturana & Varela 1980).

According to Maturana and Varela circular organisation is the basis of all living systems: it is what makes them ordered. This circular organisation creates a self-referring, or self-producing, system. It is the source of homeostasis that brings organisms back to the same internal state. As such, living systems are “organised in a closed causal circular process that allows for evolutionary change in the way the circularity is maintained, but not for the loss of the circularity itself” (Maturana & Varela 1980, p.9). The function of an organism’s circular organisation is simply to maintain its circular organisation and thus its identity in a continuously changing environment (i.e. it is self-referential). This circular order, or identity, emerges from the interactions of the system’s components. These components, whose continuous interactions together ‘create’ the emergent system whole (i.e. its circular organisation) must be constantly produced and maintained by the living system (i.e. downward causation), such that their interactions continue to produce the living system (i.e. upward causation). The organism only “maintains its identity as long as the basic circularity that defines it as a unit of interactions remains unbroken” (Maturana & Varela 1980, p.9-11).

It is emergent circular organisation and its downward causation that differentiate self-organising systems from self-regulating cybernetic systems. These features allow self-organising systems to self-produce (they make themselves) and exhibit novel behaviour. In contrast, self-regulating

1 An autopoietic system can be contrasted to an allpoietic system, such as a machine, which through its functioning produces something other than itself, such as a car or a car factory (Maturana & Varela 1980).
cybernetic systems are typically externally designed, use negative feedback to dampen change, and cannot on their own exhibit new behaviours (Capra 1997).

As such, the living system is a network pattern in which the function of each of its components is to transform other components while maintaining the overall circularity of the network (Capra 1997). Thus an autopoietic system maintains its essential identity, or overall pattern, while its parts continuously interact and change. For example, the cells in our pancreas are replaced every 24 hours, our stomach lining cells replace every three days, and most of our brain is renewed every month. Yet despite this constant flux, these organs maintain their identity (they remain a pancreas, stomach or brain), i.e. their pattern of basic of circularity (Capra 1997). It is this continuous through-flow of energy and matter that characterises living systems as open, self-organising systems, operating in conditions far from equilibrium, as per the work of Ilya Prigogine.

Boundaries, such as cell walls, membranes, skin, etc., specify the domain of the networks operations and define the system as a unit. This differs from catalytic cycles that are self-organising but have no boundaries (Capra 1997). As such, autopoietic systems are operationally closed. Maturana and Varela were able to produce autopoietic patterns and boundaries using cellular automata (mathematical network models developed subsequent to McColluch and Pitt’s cybernetic binary models, and used as alternatives to differential equations for modelling complex systems). As such, they were among the first to simulate self-organising systems (Capra 1997).

A3.2.2 Autopoietic View of Knowledge & Cognition

In 1987, as part of a contract to Organisation of American States, Maturana and Varela published the Tree of Knowledge (Maturana & Varela 1992), based on their work on autopoiesis and cognition (1980). Their book attempts to understand difficulties associated with social communication and knowledge transfer. In it they describe cognition as a continuous process of coupling (feedback) between an organism and other systems that comprise its environment. From this, they make the radical postulation that the process of circular organisation, with or without a nervous system, is identical to the process of cognition, thereby concluding that all living systems are cognitive systems, therefore living is the process of cognition. This systems theory of cognition, whereby even the simplest living systems (e.g. bacteria) are capable of cognition, is sometimes referred to as the Santiago Theory (Capra 1997). In this view, cognition is a process of bringing the world forth, rather than information processing. The authors’ key point in relation to knowledge is that “all doing is knowing and all knowing is doing” (p.27), whereby knowing is a circular recursive process.

The self-referential character of autopoiesis has been criticised by some to be a reflection of Maturana’s radical constructivist or solipsistic epistemology (Mesjasz 2010), and his belief that we see does not exist: “the activities of nerve cells do not reflect an environment independent of the living organism and hence do not allow for the construction of an absolutely existing external world” (quoted in Capra 1997, p.96). Maturana and Varela (1992), however, argue that the autopoietic view of cognition is neither extremely representational (concerning an objective reality) nor solipsistic/idealist (assuming there is no external, objective reality), because for the nervous system there is no ‘inside’ or ‘outside’.

Maturana and Varela’s autopoietic view of cognition was in direct contrast to that of the cognitive sciences, which viewed (and in many cases still does) the nervous system as an information processing devise that picks up information from its environment, and has inputs and outputs like that of a machine or computer. Indeed, Maturana and Varela regard this information processing view of cognition as “patently wrong” (1992, p.169). Advances in cognitive sciences have supported their assertions, such as that which shows the nervous, endocrine and immune systems actually form a single cognitive network (Prigogine & Stengers 1984).

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2 Capra (1997) notes that an almost identical understanding of cognition, based on patterns of relationships between living systems, was simultaneously and independently developed by Gregory Bateson (who was also influenced by cybernetics) in his book Mind and Nature: a Necessary Unity (2002).
Appendix 3

A3.1 Chaos Theory

Whereas quantum theory was revolutionary in that it saw systems as inexact, probabilistic and indeterminate, the genesis of chaos theory side-stepped such quantum notions. Rather, the theory originated out of the Newtonian paradigm and the reductionist pursuit of finding new ways to predict and control systems (Briggs & Peat 1989). Unlike their Newtonian predecessors, however, chaos theorists were focused on understanding and modelling the non-linear aspects of complex systems (e.g. Prigogine’s dissipative structures), rather than simply sweeping them under the carpet of linear approximations. With the arrival of high-speed computers, the 1970s and 80s saw a growing number of scientists studying chaos in dynamic non-linear systems (Briggs & Peat 1989).

Non-linear mathematics, together with the empirical findings of Prigogine, Haken and Eigen, had shown that deterministic systems that self-organise via iterative feedback become chaotic and unpredictable (indeterminate) when pushed beyond critical boundaries. The aim of chaos theory is to explain the behaviours of these systems, specifically how control parameters from outside the system (e.g. energy or information), drive the system’s behaviours to one state or another (these states being called attractors).

A3.1.1 Phase space

Gaining a basic understanding of chaos theory requires an introduction to the concept of phase space. As discussed earlier, the behaviours of non-linear phenomena are not easily described using quantitative methods involving equations. Rather, it is easier to use qualitative methods to visualise their behaviours. Phase space is qualitative technique for graphically viewing system behaviour in abstract mathematical space. Using this technique, every dimension, or variable, of a system’s behaviour is represented by a different coordinate on an axis in abstract space. Here is a simple example provided by Briggs and Peat (1989): a three dimensional object moving through space, such as an airplane flying over the Atlantic, would have a phase space consisting of the three spatial dimensions, plus its speed in the direction of any one of these dimensions—thus it would have a six dimensional phase space. The system’s phase space represents a blank page, the total possible behavioural space the system (i.e. the airplane) can potentially ‘explore’. Phase space also delineates the boundaries of the system’s possible behaviours. Thus phase space is a representation of both the system’s total possibilities and its outer limits. The actual trajectory of the airplane is then mapped onto the system’s phase space: the trajectory occupies only a tiny fraction of the phase space available to the plane, and thereby represents a ‘subset’ of the total possible behaviours potentially available to the system.

A3.1.2 Attractors

So it is that the behaviour of stable orderly systems represents just a tiny sub-set of the phase space (total possible range of behaviours) potentially available to them. In chaos theory, the subset of phase space to which a system is repeatedly attracted is referred to as the system’s attractor. The following is based on a description of attractors outlined by Briggs and Peat (1989). Attractors are like valleys or basins on a landscape—everything tends to roll down into them. There are different types of attractors. When a system tends to return to the same fixed state or position after being disturbed, this state is called a point or fixed attractor. A very simple example of system with a point attractor is a pendulum. However you ‘perturb’ the system (by pushing the pendulum one way or another), and however furiously it might swing, thanks to friction, the pendulum comes to rest at the exact point at which it started, which is the bottom of its trajectory. When mapped in phase space, a point attractor is just that: a one-dimensional point (Figure A3.1a). The second type of attractor is a limit cycle. Systems under the influence of a limit cycle oscillate back and forth between two different point attractors, like two valleys separated by a saddle. A pendulum given a

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3 Deterministic meaning that they system is subject to fixed rules and no randomness, and therefore, theoretically, should always produce the same output (i.e. be predictable).

4 Note this conception of phase space is a gross simplification of the actual phase space available to the airplane. If one considers that the plane consists of particles, the actual phase space would be 6n, where n=the number of particles that comprise the plane (Briggs & Peat 1989). Examination of other variables, such as acceleration or deceleration, would require addition of even more dimensions to the plane’s phase space.
periodic kick to overcome the forces of friction such that it has a regular swing is an example of a system with a limit cycle attractor. The pendulum oscillates between two positions, or attractors, which represent height of its trajectory on either side of its arc. When mapped in phase space, this limit cycle traces a two dimensional circle\(^5\) (Figure A3.1ab). The system is attracted to this cyclic path, rather than to just a fixed point. The regular cycling of predator-prey populations (e.g. trout and pike) through peaks and troughs is another classic example of a system governed by limit cycles. Systems governed by limit cycles are remarkably stable. Even when seriously perturbed (say the predator or prey population is killed off by disease), with time, populations will recover and settle back into their original limit cycle. The state of the population can be conceptualised as a point that moves round and round a circle in phase space (Briggs & Peat 1989).

The third type of attractor is a torus attractor. A torus attractor emerges when two separate limit cycles interact and fasten together, conjoining their phase spaces. An example would be if two pendulums were conjoined such that the swinging of one affected the swinging of the other. Another example would be the joining of two predator prey cycles, such as trout and pike with insects and frogs. When mapped in phase space, a torus assumes the shape of a three-dimensional donut\(^6\). The behaviour of the conjoined system can be visualised as a point looping around and

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\(^5\) Systems with more than two variables form more complex shapes, as their phase space will have more dimensions.

\(^6\) Again, this is assuming that each of the conjoined limit cycles only consist of two variables – if they have additional variables, the torus will assume a much more complicated shape.
around on the surface of the torus (Figure A3.1c). The system is attracted to this looping path, rather than just a cyclic path. Torus attractor systems are quite orderly and have asymptotic predictability: although the exact position of the system at a given time is unknown, it can still be certain that it will be situated somewhere on the surface of the torus, and not randomly wandering through phase space (Briggs & Peat 1989).

### A3.1.3 Bifurcations

Non-linear systems are attracted to stable attractors, such as point, limit cycle, and torus attractors, when their control parameters are relatively low—i.e. ‘flowing’ slowly through the system. Control parameters are factors that, as they change, move a system through different attractor states; for example, energy in the case of a pendulum, population growth in predator-prey cycles, or information flow in organisations. As explained by Stacey (1996), any potential instability caused by increases in these parameters is small enough to be damped down by the systems’ negative feedback loops. However, as these parameters are ‘dialled up’, they begin to exceed the system’s damping capacity. The behaviour of the system begins to bifurcate and its stable pattern becomes more complicated.

Briggs and Peat (1989) describe a bifurcation as a point of instability in a system where its behaviour forks and branches off in a qualitatively different direction, forming a new attractor. To illustrate the bifurcation effect, they use the example of a non-linearly growing population as shown in Figure A3.2, with growth rate charted against the population as a percent of its original size. The growth rate increases until it reaches a critical point (~r=3.0) where the system bifurcates and suddenly the population starts oscillating between two stable values. The system’s behaviour is now governed by a limit cycle attractor. If the growth rate continues to increase, it reaches yet another critical bifurcation point (~r=3.5), and now the population starts oscillating between four stable values. The system is now governed by a torus attractor. With more rate increases, the system quickly bifurcates again and again, oscillating between eight stable values, then 16. Although still predictable, the system is now very complicated; in phase space the surface of the system’s torus attractor is beginning to break apart (Figure A3.2). From this point, the system’s behaviour rapidly descends into chaos: jumping wildly and unpredictably around in phase space. The surface of the system’s torus attractor has now broken up and entered a fractional dimension, whereupon it may then form a strange attractor (e.g. Figure A3.1d). The study of chaos looks at what happens to stable systems when they break out of their orderly patterns of behaviour and begin to explore the wider phase space available to them (Briggs & Peat 1989).

To help understand chaos, Briggs and Peat (1989) present an interesting metaphor. Think of a stable system as a piece of paper, a two dimensional object. Then start crumpling it—the folds and crumples represent turbulence, or chaos. The more you crumple the page together, the more it begins to resemble a three dimensional ball. The paper is now caught between the dimensions of a two dimensional plane and a three dimensional solid. Thus, chaos indicates the transition where the system is caught between two different dimensions, or system states, which exhibit qualitatively different patterns of behaviour (Briggs & Peat 1989). This means the new system state is no longer topologically equivalent to the previous. A system approaching this transition point between two qualitatively different states is often referred to as being on the edge of chaos. As a system approaches the edge of chaos, it becomes highly sensitive: even the slightest perturbation can cause radical changes in its behaviour.

A system transitioning through chaos to reach a higher level of order is exemplified in the case of Prigogine’s experiments with Benard cells. As the fluid is heated, it reaches a critical point where turbulence, or chaos, sets in. This represents a point of indecision for the system, where it

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7 Scientists have found that these critical bifurcation points occur at the point where the system’s period (i.e. the time it takes for the system to oscillate back to its starting point) doubles (Briggs & Peat 1989).

8 Another easy to visualise example is the effect of increasing stream flow around a rock. Under low flow, water parts smoothly around the rock. As the flow increases, a stable vortex forms behind the rock, which then bifurcates into more and more vortices. Eventually, the vortices erupt into complete turbulence, and there is no longer any apparent order: the flow has become chaotic (Briggs & Peat 1989).
fluctuates wildly between a higher and lower dimension of order, until it finally jumps to the higher dimension: a stable hexagonal pattern of Benard cells.

Figure A3.2. Graph of a non-linearly growing population, with growth rate (r) charted against the population (x) as a per cent of its original size (adapted from: Wikipedia).

A3.1.4 Strange attractors

In the left and centre areas of Figure A3.2 (where r= 2.4 to 3.6), the trajectory of the system occupies a small subset of its phase space. In contrast, the darkened areas of the graph (where r=3.6 to 4.0) show the system chaotically jumping all over, filling up its phase space. However, one can also see an underlying meta-pattern in the chaos: the arching black lines, where there is the highest probability of finding the system, and the intermittent white bands, interludes of stability where the system oscillates between fixed points again. As the system iterates, it bends and folds on itself, creating bands of intermittent order and chaos (Briggs & Peat 1989). When its chaotic behaviour is mapped, it is shown to occupy a completely new region of phase space. Although the system’s behaviours never quite repeat themselves while in the chaotic phase, they follow similar trajectories. In abstract phase space, their iterations form complex patterns, which are irregular but recognizable, the shape of which is the system’s strange attractor (Briggs & Peat 1989). Although the quantitative features of a chaotic system cannot be defined, its qualitative features can (Capra 1997). The system’s behaviour is no longer restricted to a limited selection of stable points: it now has infinite choices. But these choices are confined within the shape of the strange attractor, the source of the meta-pattern seen on the right side of Figure A3.2. As such, strange attractors are paradoxical: they are simultaneously stable and unstable, ordered and disordered, at equilibrium and disequilibrium (Stacey 1996). Strange attractors take distinctive shapes, such as the well-known Lorenz, or butterfly, attractor (Figure A3.3a), which represents the behaviour of the Lorenz weather system in phase space, or the horseshoe attractor, discovered in the 1960s by a mathematician using topology to examine noise in an electrical feedback system (Briggs & Peat 1989).9

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9 Briggs and Peat (1989) provide the interesting example of researchers in California who were looking to see if there is order in a dripping tap (previously presumed to be random). They recorded the time intervals between 4000 drips. When graphed as points, the intervals made a decidedly non-random pattern. In fact, the pattern was a cross section of a strange attractor previously generated by an iterating equation developed by a French scientist named Henon. When the researchers zoomed in on these patterns, they found they were self-similar, smaller scale versions of the same pattern. When they increased the water pressure in the tap and repeated the experiment, the graphed patterns formed cross-sections of new, previously unknown strange attractors (Briggs & Peat 1989). Ruelle (1980) has proposed that strange
Thus, whereas chaos was once considered equivalent to randomness or entropy, it is now understood that chaotic systems actually have deep, underlying patterns of order that assume qualitatively distinct shapes—strange attractors (Capra 1997). However, it should be noted that systems driven into turbulence do not necessarily reconfigure into higher dimensions of order represented by strange attractors. They may instead disintegrate into more disordered states (Stacey 1996).

**Figure A3.3.** Shapes of strange attractors as they appear when mapped in three dimensional phase space: (a) the Lorenz butterfly attractor, and (b) the Rossler attractor (source: El Nachie 2006).

### A3.1.5 Fractals

**Fractal geometry** is another means of describing chaotic patterns. Developed in the 1960s by the brilliant mathematician Benoit Mandelbrot, fractal geometry explains the irregular but self-similar patterns seen everywhere in nature, patterns which cannot be described with conventional geometry (Figure A3.4). Fractal geometry was soon taken up by mathematicians to describe the fine-scale structure of chaotic patterns (Capra 1997). Although fractal patterns are often incredibly complex, they are described using very simple iterative mathematical formulas, i.e. formulas that repeat back on themselves, creating feedback loops. For example, the Mandelbrot set of mathematical points is generated by iterating the complex quadratic polynomial $z_{n+1} = z_n^2$.

Surprisingly, mapping the points generated by this simple formula creates the most complex mathematical object ever invented (Capra 1997), one of bewildering, bewitching and almost indescribable complexity. The Mandelbrot set is best experienced in animated format, which allows the viewer to ‘zoom through’ the object’s complex boundary (e.g. [http://www.youtube.com/watch?v=ivRQDAbduM](http://www.youtube.com/watch?v=ivRQDAbduM)).

The irregularity, or jaggedness, of fractal patterns is an expression of system’s chaos. Fractal patterns repeat themselves at descending scales, such that the pattern of the whole is reflected in the pattern of the parts. They are found everywhere in nature, for instance: trees, forests, coastlines, snowflakes, mountains, edges of clouds, blood vessels, river deltas, and vegetables such as broccoli (Capra 1997).

Fractal patterns also illustrate the limitations of quantitative analyses. For example, Mandelbrot related fractal geometry to the question “how long is the coast of Britain?” (1967). Because the coast is jagged, and this jaggedness is self-similar at all scales, it depends on the scale at which you attractors are “chinese (sic) boxes of subtle order” (quoted in Briggs and Peat 1989, p.89), inhabiting the fractional realm between the three dimensions of the familiar, ordered world.
measure it (Figure A3.5). The coast is indefinitely long if measured at smaller and smaller scales. In other words, quantities of fractal (chaotic) systems can never be definitively defined because they are dependent on the scale of observation. However, the coast can be described qualitatively, by generating a ratio of its relative jaggedness (Capra 1997). Jaggedness is a measure of the system's chaos (the more jagged, the higher the fractal dimension and therefore more chaotic) and is relative to scale. For example, if you look very closely along the water's edge, the coast looks jagged, if you are standing in a bay looking down the coast it looks relatively smooth; from a low plane it looks jagged, whereas from higher in space it looks smooth. This changing perspective reveals how order is laminted with chaos in non-linear systems.

Figure A3.4. Trees are examples of natural fractal objects. Notice the branching repeats itself at different scales, but is never exactly the same (source: Spehar et al. 2003).

Figure A3.5. How long is the coast of Britain? Because the coast is jagged, and this jaggedness is self-similar at all scales, it depends on the scale at which you measure it (Mandelbrot 1967). The coast is indefinitely long if measured with smaller and smaller units. (Source: Wikipedia).

A3.1.6 Sensitivity to initial conditions & the edge of chaos

A key feature of dynamic non-linear systems is their extreme sensitivity to initial conditions. Because these systems are iterative, by virtue of feedback very tiny perturbations can be amplified
into very large effects through positive feedback (Briggs & Peat 1989). For example, measurement has finite precision, and computers can only do finite calculations. Therefore infinite strings of decimal places must be rounded off at some point. Yet no matter how many decimal places are conserved in the numbers fed into non-linear equations, after a number of iterations the round-off error is amplified to such a degree that the computations become chaotic and prediction is no longer possible (Briggs & Peat 1989). Gregory Chaitin used a new information theory proof to show Godel’s Incompleteness Theorem (see Appendix 2) is not just a ‘mathematical curiosity’. Rather, it is a reflection of this iterative paradox, with Godel’s missing information corresponding to the uncertainties and rounding-off errors in non-linear equations that are amplified through iteration (Briggs & Peat 1989). This missing information sows the seeds of chaos and unpredictability found in most natural systems.

As such, even when modelling deterministic non-linear systems, which in theory should be predictable, chaos inevitably emerges. Crutchfield et al. (1986) provide a vivid illustration of this extreme sensitivity. They state that if one was able to measure and control every single variable involved in striking a billiard ball, the trajectory of the ball could no longer be predicted after one minute if one’s calculation neglected the gravitational effect of a single electron on the edge of the galaxy. They elaborate by noting that:

The large growth in uncertainty comes about because the balls are curved, and small differences at the point of impact are amplified with each collision. The amplification is exponential: it is compounded at every collision, like the successive reproduction of bacteria with unlimited space and food. Any effect, no matter how small, quickly reaches macroscopic proportions. That is one of the basic properties of chaos. (p.50)

This vast sensitivity is indicative of a system’s interconnectedness, its wholeness. For this reason, complex systems are resistant to reductionist analysis requiring some part of the system to be cut off from ‘external’ feedback loops (i.e. holding other parts of the system constant) so it can be examined in isolation (Anderson 1999). Thus, whenever scientists go the reductionist route of attempting to measure and model parts of dynamic non-linear systems, the round-off error or the ‘missing information’, quickly renders prediction impossible. Uncertainty and errors with regard to the system’s initial state seed the system’s future with potential turbulence and chaos (Briggs & Peat 1989). Order and chaos co-exist within non-linear systems.

A3.1.7 Causality

The Newtonian conception of a determinate universe is one where all events are the result of cause and effect (upward causation). Therefore, given complete information about all the forces at work in nature, one could predict the future, as famously conjectured by Laplace (Capra 2010), in what Polanyi (1962, p.141) called the “Laplacian Delusion.” This notion of the universe assumes that all processes are reversible, and therefore the universe is timeless, there is no ‘arrow of time’. Thus the irreversibility we perceive in our day-to-day lives is actually an illusion. Newtonian physicists noticed the irreversible effects of friction but ignored them. 19th century thermodynamics put the

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10 Briggs and Peat (1989) describe how a system’s susceptibility to chaotic behaviour depends on whether it is periodic or quasi-periodic. A system is periodic when the start and end points of its behavioural cycle are the same (this happens when periods/frequencies of the two coupled systems form a simple ratio, a rational number). A system is quasi-periodic when it looks periodic but never exactly repeats itself, so its end point is always different from its starting point (this happenswhen the periods/frequencies of the two coupled systems do not form a ratio; rather they are irrational, having decimal expression with infinite, non-repeating terms). Quasi-periodic systems are more stable because they never return to the same point between oscillations, therefore there is little opportunity for resonance (which creates amplification and positive feedback, and can potentially knock the system out of its pattern/cycle of behaviour). Periodic systems, on the other hand, are unstable because they always return to the same point between oscillations, making them prone to resonance with repeated iterations, i.e. amplification/positive feedback. Because of this, periodic systems are susceptible to descending into chaos and “gothic complexity” (Briggs and Peat, 1989, p.43). This observation has been backed by observations of Jupiter’s asteroid belt. Gaps have been found in the places where an asteroid’s orbit would be in a periodic cycle with Jupiter’s orbit, indicating that any asteroids attempting to occupy the gaps are likely to be shot off into space (Briggs & Peat 1989).
first dent in this conception, with introduction of entropy (Capra 1997), but this was clawed back when Boltzmann devised probability theory to reconcile entropy with Newtonian laws. Both quantum and classical dynamics likewise presume time is reversible (Briggs & Peat 1989). It was finally Prigogine, with his work on open systems far from equilibrium, who presented strong arguments in favour of an arrow of time, as indicated in the irreversible complexity emerging out of chaos in dissipative systems. He argues that the dynamic bifurcations of complex systems reveal that time is irreversible (Prigogine & Stengers 1984). Although causality is a continuous force, each bifurcation of the system is a decision-point where many futures are possible. The path the system chooses is unpredictable, and once it chooses, the other potential futures vanish irreversibly (Briggs & Peat 1989). Crutchfield et al. (1986) weigh in on the argument by stating:

It is the exponential amplification of errors due to chaotic dynamics that provides the second reason for Laplace's undoing. Quantum mechanics implies that initial measurements are always uncertain, and chaos ensures that the uncertainties will quickly overwhelm the ability to make predictions. Without chaos Laplace might have hoped that errors would remain bounded, or at least grow slowly enough to allow him to make predictions over a long period. With chaos, predictions are rapidly doomed to gross inaccuracy. (p.50)

Indeed, Prigogine believes that by clinging to cosmic reversibility, quantum and classical physicists are idealising nature (Briggs & Peat 1989). He argues that all natural systems are indeterminate, and that the laws of the universe are not given, or static and unchanging. Rather they emerge and evolve as bifurcations and amplifications increase systems’ complexity through time, a view that has raised the ire of some physicists (Briggs & Peat 1989).

### A3.1.8 Creativity

Prigogine also notes that bifurcation points involve amplification of small effects. He regards the amplification capacity of self-organising systems to be their “creative lever”, as it allows for the spontaneous emergence novel patterns of order (Briggs & Peat 1989, p.145). As discussed earlier, when a system is approaching chaotic, or turbulent, conditions (i.e. the edge of chaos), it becomes highly sensitive to small disturbances, which can potentially blow up into large, unexpected effects. As such, Briggs and Peat (1989) note that biological systems employ negative feedback to dampen and prevent amplification of small effects and maintain homeostasis (i.e. their ordered pattern). However, the reverse is true in parts of biological systems requiring flexible and creative behaviour; they maintain edge-of-chaos conditions, and are therefore very responsive to small effects and external stimuli (Briggs & Peat 1989).

### A3.2 Complex self-organising systems

Whereas chaos theory is concerned with searching for the deterministic parameters that drive particular non-linear systems and the underlying order in chaotic systems, complexity theorists are interested in the patterns of spontaneous order that emerge from the interactions of networked agents, and the behaviour of ordered systems nearing the edge of chaos (Levy 2000). Despite apparent commonalities with cybernetics and systems theory, the complexity sciences emerged separately in the 1990s as a result of computer-based explorations into non-linear dynamics, and interest in genetics and biological evolution (Heylighen et al. 2007). Among these early complexity scientists was evolutionary biologist Stuart Kauffman. Kauffman was a member of the Santa Fe Institute, a non-profit centre dedicated to the interdisciplinary study of complex systems. The institute was set up in 1984 by scientists previously working with the Los Alamos National Laboratory, who were disenchanted highly reductionist and specialised approaches to science, and who were intrigued by recent advances in non-linear dynamics and computer modelling (Dillon 2001). In his work, Kauffman used binary, or Boolean, networks (which had been first developed by cyberneticists in the 1940s) to model enormously complex biological and chemical systems that could not otherwise be described using differential equations (Capra 1997).

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11 The institute was once headed by Robert Oppenheimer, who oversaw the laboratory’s nuclear weapons program.
A3.2.1 Binary (Boolean) networks

Capra (1997) provides a basic description of how these binary networks operate. Simple binary networks consist of six nodes, each connected to three neighbouring nodes, with each node capable of having a value of either ON or OFF. Simple switching rules can be established for the network, whereby the value of a node is determined by the prior values of its neighbouring nodes. This creates sequences of on-off states within the nodes, and different patterns of sequences can be seen to emerge as the network cycles. These sequences can then be mapped in six dimensional phase space, and classified according to their attractors (i.e. basins of attraction). For example, the sequence may settle into a stable state where the nodes are all off, and hence the network no-longer changes (point attractor). Or the sequence might run a few steps then start oscillating between two different states (limit cycle attractor). Because binary networks are deterministic (the network has a finite number of states, regardless of how large it is), they always return their initial state at some point, meaning they are periodic. Thus, given enough time they settle into one of their attractors and remain in that state (Capra 1997). Chaotic systems have infinitely long attractors consisting of seemingly random states, whereas ordered systems have small, ordered attractors, boxed into localised regions of phase space (Kauffman 1993).

A3.2.2 NK Model & the edge of chaos

Kaufmann (1993) examined the behaviours of many large ‘NK’ Boolean (binary) networks\(^\text{12}\) to try and discern the relationship between chaos and order in complex systems. These models show self-organisation in random networks, or what Kauffman calls ‘order for free’. From his observations Kauffman noted that the behaviours of these networks fall into three broad regimes: ordered, complex and chaotic. The behaviour of the Boolean networks is driven by two key parameters: the number of nodes (N) in the network, and the average number of connections (K) between the nodes. If the number connections diminish, the system eventually freezes into a fixed state of activity such that its behaviours have become highly ordered and unchanging. These systems crystallise order, such that changes cannot propagate through the network. In cases where the number of connections between nodes increases, the system eventually becomes chaotic. Here the system fluctuates erratically between multiple states. It is very sensitive to small changes, which can cause large ‘avalanches’ of change to propagate through the system, demonstrating its sensitivity to initial conditions. As system moves from an ordered to a chaotic state, it passes through a transition phase where the system has a ‘frozen’ core of nodes, which remain unchanged as the rest of the system fluctuates in complex ways; in this phase small changes are likely to create small avalanches of change, and occasionally large avalanches. Kaufmann called this system transition phase the edge of chaos. From these models Kauffman hypothesised that living systems characteristically occupy this half-way state on the edge of chaos, where they have sufficient flexibility to adapt and evolve while still maintaining stability in the essential processes that give them their identity (Kauffman 1993).

A3.2.3 Evolution through self-organisation

Kaufmann (1993) sees an inseparable relationship between selection and self-organisation. An organism alters its biophysical environment while being simultaneously altered by the same environment. The dynamic of a system is co-determined by its own internal dynamic, and by the size and connectivity of the other systems that are part of the bigger system to which it also belongs. Thus all organisms are coupled with their environments, co-evolving in dynamically shifting ‘fitness landscapes’. He goes on to suggest that linked co-evolving natural systems are mutually moved “as though by an invisible hand” (p.29) to the edge chaos. Here they form ecosystems through which co-evolutionary changes propagate, with areas of instability propagating both speciation and extinction. When Kauffman ran NK fitness landscape models, he found that fitness landscapes with higher K values (i.e. connections between nodes) sustained higher overall fitness, with species co-evolving more quickly into sustained fitness and Nash equilibrium\(^\text{13}\).

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\(^{12}\)Bearing in mind these are formal deterministic models, with well-defined variables to ensure predictability and computability.

\(^{13}\)A level of stability reached once no player, or agent, in the system will gain further benefit by altering its strategies.
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Kauffman’s (1993) evolution simulation models showed that randomly interacting entities in a system very quickly connect via feedback loops into autocatalytic strings. These strings then form autocatalytic networks (hypercycles), all in absence of any selective pressure. In the Darwinian understanding of evolution, new life forms gradually evolve as useful variations accumulate under selective pressures. While he does not completely discount Darwinian evolution, Kauffman proposes that the ‘order for free’ exhibited by self-organising systems helps explain the emergence of life and its full array of complexity (Kauffman 1993).

Although complex systems are under continuous selective pressure, Kauffman’s work shows that the more complex systems are, the more resistant they are to alteration as a result of selective pressures. His work also shows that complex systems spontaneously self-organise into “profound order” (p.29). This new order is maintained if selective pressures fail to squash it. Thus, Kauffman (1993) conjectures that spontaneous self-organisation is evolution’s driving force, with new life forms emerging in spite of selection, not because of it: “Evolution is not just ‘chance caught on a wing.’ It is not just a tinkering of the ad hoc, of bricolage, of contraption. It is emergent order honoured and honed by selection.” (p. 644)

Kauffman’s models have proven to have predictive value in a number of areas in molecular biology. For example, it has been shown that an organism’s genome operates as a vast network of interconnected feedback loops, whereby genes regulate each other’s activities, a notion that differs substantially from earlier views of a genetic ‘code’ acting like a “biochemical computer executing a ‘genetic program’” (Capra 1997, p.199).

A3.2.4 Creative wholeness

Kauffman (1995) argues that the modern reductionist paradigm begins to fail once it attempts to describe the self-organising natural (and human) world. This is because the complex wholes of these systems, governed by their own emergent laws or properties, cannot be explained by examining their parts. Indeed, he sees theories of emergence as pointing to our wholeness with the universe, as we participate in its collective unfolding. He also sees the endlessly creative phenomena of emergence as a vehicle for ‘reinventing the sacred’ in the modern world (Kauffman 1995).

A3.3 Complex Adaptive Systems

In the 1990s, John Holland, a computer scientists and engineer, elucidated his ideas on complexity in a series of lectures for the Santa Fe institute. He later compiled these lectures into his book Hidden Order – How adaptation builds complexity (1995), which he followed with Emergence in 1998 (Holland 1998). His work is concerned with understanding complex adaptive systems (also referred to as multi-agent systems), a term coined by the Santa Fe Institute to describe complex systems that are capable of adapting, i.e. learning.

A3.3.1 Emergence & adaptation

According to Waldrop (1994) complex adaptive systems are dynamic networks comprised of large numbers of interacting entities called agents. These agents are constantly acting and reacting to what the other agents in the system are doing. Cells, organisms, ecosystems, ant colonies, language and cities are all examples of complex adaptive systems. The overall behavior of the system is the result of a huge number of decisions made every moment by many individual agents. Thus, the most important feature of complex adaptive systems is their ability to self-organise into ordered patterns as a result of the interactions between their agents, without any external control or design. As such, the control of a complex adaptive system tends to be highly dispersed and decentralized (Waldrop 1994). Once formed, the self-organised emergent order typically resists change (Seel 2006). The phenomena of large scale order, or patterns, emerging from small-scale interactions between individual parts, or agents, is called emergence (Holland 1998).

From this comes another key feature of complex adaptive systems: the ability to learn and adapt to their surroundings (Holland 1995). Holland indicates that this notion of adaptation expands the
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biological usage of the term (a process whereby an organism fits itself to its environment to make better use of it over time) to include learning-based processes, which he essentially equates to information processing (Holland 1995).

A3.3.2 Elements of complex adaptive systems

Holland (1995) describes complex adaptive systems as being different from most scientifically-studied systems because they maintain coherence in the face of change via anticipation and conditioned action, and without central direction. According to Holland, complex adaptive systems have seven basic elements: 1) aggregation—a property of complex adaptive systems that allows for the emergence of unified complex large-scale behaviours from the aggregation of less complex agents (e.g. an ant colony from ants), which then act as meta-agents; 2) tagging—a mechanism that facilitates the formation of aggregates through selective interaction via cooperation, specialisation, filtering, etc.; they define the network by delimiting its major interactions/connections; 3) nonlinearity—a property which causes the behaviour of the aggregate to always be more complicated than the sum of the behaviours of its component agents; 4) flows—which dictate how resources flow across the network, and are subject to multiplier and recycling effects; 5) diversity—a dynamic pattern within the complex adaptive system that is a product of progressive adaptations and the specialised niches occupied by its constituent agents; 6) internal models—mechanisms of anticipation used by agents in the system, mental maps or schemata that help them predict the future and prescribe current action accordingly; and finally, 7) building blocks—mechanisms by which agents use recycled experiences as components to build their internal models (Holland 1995).

A3.3.3 Exploration & exploitation

Holland (1987) states that complex adaptive systems interact with their environments in 'game-like' ways, meaning they are motivated by pay-offs that afford them with continued existence and adaptation. Likewise, agents in a complex adaptive system, unable to forecast their impacts on the wider system behaviour, simply behave in ways that optimise their own fitness, not that of system to which they belong. The environment supplies an enormous range of niches that the complex adaptive system exploits a subset of. Holland (1987) suggests that the complex adaptive system makes a trade-off between exploration and exploitation. A complex adaptive system can exploit an old niche where there are well-established payoffs, or it can explore new possibilities in a new niche, but at the cost of leaving the old niche and its predictable pay-off for unknown gains. He describes emergence largely in relation to game-theory, as patterns that emerge from game playing agents (Holland 1998), which is reflective of models applied by classical economists (e.g. wage-contract games).

A3.3.4 Reductionism & Mechanism

Holland (1995) argues that understanding how complex adaptive systems work will help us locate lever points in the system, and therefore resolve problems in such systems (e.g. immune disease, inner city decay, business innovation, etc.). In Holland's view, an understanding of emergence will help us control previously uncontrollable aspects of the world, by allowing us to find ways of fostering the emergent phenomena we want, and discouraging the ones we do not (Holland 1998).

Although Holland (1998) argues that emergence of rules-governed systems is the opposite of reduction, his approach to understanding complex adaptive systems (unlike Kauffman's) nonetheless strongly emanates from the paradigm of mechanism and reductionism. His work focuses on decomposing complex phenomena into their component parts and determining their causal mechanisms in aid of building models that can improve prediction and control of such systems. In his descriptions of how agents adapt (Holland 1995), he uses terms such as: performance, inputs, outputs, messages, signals, processing, performance, and syntax. In doing so, Holland reveals a conception of organisms as information processing machines, or computers. Indeed, he defines agents as "a collection of message-processing rules" (Holland 1995, p.46). As such, his theory is cognitive, relying on system agents having internal/mental models of external reality, which in turn govern their behaviour.
While Kauffman refutes Darwinian selection as a source of complexity and instead sees complexity arising spontaneously as a result of systems moving towards chaos, Holland’s thinking is more Darwinian—he views adaptation as the source of complexity. Stacey et al. (2000) reject Holland’s conception of complex adaptive systems because of its formative causality, believing Holland’s view fails accommodate free will (downward causality) or explain the emergence of truly novel behaviours.

A3.4 Summary & Conclusion

Metaphysical holism saw a revival amongst scientists in the 1920s, after quantum discoveries revealed the interconnected nature of the universe. However, by the end of WWII, holism had been stripped from mainstream science and replaced with a renewed emphasis on reductionism. Heylighen et al. (2007) suggest that reductionism eclipsed holism because Newtonian approaches were so successful; as a result, it was thought they could explain everything. By comparison, holism had a mystical sensibility that seemed to lack scientific foundation (Heylighen et al. 2007). Holism pointed to the tendency of wholes to be greater than the sum of their parts, but begged the question, what exactly is it that is ‘more’ in the whole? (Heylighen et al. 2007) This question remained unanswered until the late 1960s, when high-speed computers led to the formulation of non-linear mathematics. From non-linear mathematics arose the chaos and complexity sciences, fields of study concerned with the emergence of structure, order and patterns from complex and apparently disordered/chaotic systems.

This appendix outlines a selection of conceptual contributions from the chaos and complexity sciences. From Prigogine’s work (Prigogine & Stengers 1984) came the field of non-linear thermodynamics. Prigogine showed that complex self-organising systems are dynamic, open systems operating far from equilibrium, and coined the term dissipative structure to describe such systems. He showed how these systems have unpredictable, nonlinear behaviours as a result of feedback loops. Negative feedback loops help maintain system stability, whereas positive feedback loops create system instability and turbulence, or chaos, from which new forms of order can spontaneously emerge.

Shortly thereafter, Maturana and Varela introduced the notion of autopoiesis to describe how entities can be understood as units of interaction, rather than as ‘things’ (Maturana & Varela 1980, 1992). Autopoiesis is premised on self-referring circular organisation (via feedback loops) as the basis of homeostasis and all living systems. Having circular organisation means living systems are subject to both upward and downward causation. Upward causation, whereby the continuous patterns of interaction of the system’s parts generate and maintain the system whole, and downward causation whereby the emergent pattern of the whole governs the behaviour of the system’s parts such that their interactions continue to maintain the coherence or identity of the system whole. Maturana and Varela also apply autopoiesis in their Santiago Theory of cognition, whereby cognition is understood as a continuous process of coupling (feedback) between an organism and other systems that comprise its environment. From this, they make the postulation that all living systems are cognitive systems, which together bring the world forth.

Chaos theorists meanwhile worked to mathematically explain and model the behaviours of complex non-linear systems (Briggs & Peat 1989). They used the concepts of phase space, system attractors, bifurcations, and turbulence to describe how control parameters drive system behaviours from one attractor state or another. In particular, they examined what happens to orderly systems when they break out of their regular patterns and begin to chaotically explore the wider phase space available to them. It is now understood that chaotic systems actually have deep, underlying patterns of order that assume qualitatively distinct shapes—strange attractors. Chaos theory also showed that dynamic non-linear systems are extremely sensitivity to initial conditions, particularly when they are on the edge of chaos, indicating their vast interconnectedness, or wholeness. Very tiny perturbations can be amplified into very large effects through positive feedback. As such, in non-linear systems change can be a causal, meaning a stable system can spontaneously undergo rapid change and become chaotic, and a chaotic system can become spontaneously ordered into a stable and novel pattern. Thus, chaos and stability are shown to co-exist in all non-linear systems, and chaos is
revealed as the ‘creative lever’ of the universe. The work of chaos theorists suggests there is no cosmic ‘arrow of time’; as such, the processes that make up the universe are irreversible, refuting Newtonian notions of a predictable universe driven by cause and effect.

In the 1990s, complexity theorists began examining and modelling patterns of order that emerge from the interactions of networked agents, and the behaviour of ordered systems nearing the edge of chaos. This included Kauffman’s (1993) work on self-organising systems, and Holland’s (1995) work on complex adaptive systems. The systems modelled by complexity theorists are comprised of large numbers of interacting entities called agents. Kauffman showed how these system agents continuously change their behavior as they cooperate and compete amongst themselves and adjust to the external environment—likewise their external environment and other agents are always changing in response, in a dynamic co-evolving fitness landscape. Due to their ability to evolve and adapt to their environment, Holland refers to self-organising systems as complex adaptive systems. Computer modelling shows that as multiple independent agents continuously interact, they spontaneously organise and reorganise themselves into more elaborate structures over time via feedback. Because the whole of the complex system is greater than the sum of the parts, the system will exhibit emergent patterns of behaviour not seen in its constituent agents on their own. In other words, emergent order forms spontaneously and cannot be predicted from the form or properties of a system’s parts. The phenomena of large scale order, or patterns, emerging from small-scale interactions between individual parts, or agents, is called emergence. Once formed, emergent order typically resists change and attempting to change such systems using centralized control or structure will have limited effectiveness. However, Kauffman’s computer simulations show that increasing the diversity of agents, and/or the connectivity and rate of information flow between them, facilitates emergence of new behaviours in complex systems, by nudging them toward the ‘edge of chaos,’ where they are simultaneously both stable and unstable. As such, these systems vacillate continuously between order and chaos, and are dynamically shaped by the connections between agents within the system, as well as the system’s connections with outside networks. Kauffman proposes that evolution is driven by this process of creative self-organisation and the novel order it generates; he sees natural selection a force which ‘squashes’ new order rather than creates it.

After Smuts coined the term holism in 1927, the theory was soon brought down by positivist scientists on grounds of mysticism, because it provided no answer to the question “What is it that is ‘more’ in the whole?” From the above discussion, we see this question has now been answered by the chaos and complexity sciences. The ‘more’ constitutes emergent properties, the qualitatively novel patterns of behaviour that spontaneously self-organise in non-linear systems operating far from equilibrium (Heylighen et al. 2007). As such, we now know that Smuts’ holism was referring to the phenomenon complexity scientists call emergence (Heylighen et al. 2007)—the critical piece of information missing from reductionist thinking, as per Godel’s Incompleteness Theorem, and the source of the qualitative ‘jump’ that takes a system from one logical level to another (Appendix 2), as the greater whole emerges from the interactions of its parts. In furnishing this missing information, chaos and complexity theory have revealed holism and reductionism to be paradoxically wedded in a unity of opposites, as per the ancient teachings of Heraclitus.

Kauffman (1995) describes his complexity theories as “rooted in unrepentant holism, born not of mysticism, but of mathematical necessity,” (p.69). And so it is that mathematics have filled the vacuum left by reductionism’s domination of mainstream science. Capra (1997) asserts that:

The new mathematics of complexity is making more and more people realise that mathematics is much more than dry formulas; that the understanding of pattern is crucial to understand the living world around us, and that all questions of pattern, order, and complexity are essentially mathematical. (p.150)

The body of this thesis deals with seemingly intractable problem of knowledge transfer. Godel’s Theorem indicates that such problems cannot be solved using the rules and premises governing the system within which the problems are situated. They can only be solved by adding new premises or ‘rules’, i.e. by ‘jumping’ to a higher logical level and into a new frame of reference, as per the Theory
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of Logical Types. This thesis synthesises the mathematical understandings of the chaos and complexity sciences into a new metaphysical framework, one which is of a higher logical order than that of the reductionist Newtonian paradigm, and based on a new set of premises about the nature of reality.
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APPENDIX 4

A SOCIAL SCIENCES PERSPECTIVE: ORGANISATIONAL MANAGEMENT, LEARNING & KNOWLEDGE
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A4.1 Introduction

Environmental scientists have traditionally held a relatively simplistic view of knowledge transfer as a mechanical process of transferring research findings from scientists to managers and management institutions. The focus of such knowledge transfer efforts has largely been on improving:

- salience, credibility and legitimacy of research and modelling results,
- interpretation of research/modelling results into information that is relevant and compelling to target audiences/users,
- distribution of generated information/models to the ‘right’ audiences/users, and
- institutionalization of information/models in organizational memory and structures (i.e. policy and procedures).

This approach, which Huber (1991) describes as a behaviourist approach to learning, is premised on the assumption that if an entity receives and processes information, its behaviour will change. In practice, however, knowledge transfer has proven to rarely be successful in terms of creating sustained behaviour change (Easterby-Smith et al. 2008; Roux et al. 2006). As such, using knowledge transfer as a means to improve the adaptive capacity of our socio-economic system has proven to be a somewhat intractable, i.e. ‘wicked’, problem.

So why is it that efforts to improve research uptake by decision-makers so often fall short, despite growing recognition that sustainable resource management requires the ongoing integration of new and relevant knowledge? McNie (2007) states that: “we have little understanding of ‘knowledge and decision systems’ and lack a framework for understanding, researching and improving upon decision processes, particularly with regard to environmental decision-making.” This lack of understanding has in part been attributed to the failure of those in the natural sciences to appreciate the contributions of the social and behavioural sciences (National Research Council 1999). This is a considerable oversight, given that most of the barriers to improving the adaptive capacity of institutions are related to social processes operating both within and outside of these human systems (Allen 2001).

For decades, issues around cognition, learning, and behaviour (including decision-making) have occupied social and behavioural science scholars. Findings from these fields demonstrate that learning and behaviour change are the result of complex cognitive and social processes. Rarely does the presentation of new information on its own, regardless of how compelling, cause substantial changes in individual or organizational behaviours (Argyris & Schön 1974, 1978; Bartunek & Moch 1987; Markus & Zajone 1985; Weakland et al. 1982). Indeed, the complexities and difficulties have been shown to multiply when attempting to transfer knowledge between organisations because of the “multifaceted nature of the boundaries, cultures, and processes involved” (Easterby-Smith et al. 2008).

The post-industrial economy is referred to by some scholars as the knowledge economy, as it is knowledge rather than craft and industrial technology that drive competitive performance of organisations (Jashapara 2004, citing others). As such, the fields of organisational learning and...
knowledge management have gained over strength over the last 50 years as scholars and practitioners across at least 14 different disciplines have concerned themselves with issues around organisational management, organisational learning and the effective sharing and application of knowledge (Valente & Rogers 1995). Many of these fields draw on theories of individual learning, as well as systems theory and, more recently, complexity theory.

The purpose of this appendix is to highlight selected concepts in social sciences literature that are referred to in the body of this thesis, and which have potential application to knowledge transfer in an environmental management setting. This overview includes some key contributions from the economics, management, psychology, organisational learning and knowledge management literature.

A4.2 Economics & Rational Choice Theory

By the 18th century, philosophers such as Hume and Smith were beginning to discuss ideas about laws governing the complex interactions involved in producing, distributing and consuming goods, i.e. the economy (Hausman 2008). In 1776, Adam Smith published his classic explanation of how individuals in pursuit of their own interests, create unintended consequences, i.e. the ‘invisible hand’ unintentionally promoting the interests of society (Hausman 2008). Thus economics has since been primarily interested in the cumulative consequences of individual pursuit of wealth, and one of its primary branches of inquiry concerns rational choice (Hausman 2008). Rational choice theory attempts to explain and predict socio-economic patterns and phenomena arising from multiple individual choices, as individuals attempt to maximize their benefits and minimise their costs. These choices are assumed, to some extent, to be rational (Hausman 2008).

Rational choice theory is predicated on the notion that when given an option, an individual (i.e. agent in a system) will always choose the option with the greatest utility; utility being an objective measure of value or ‘goodness’ (Heylighen et al. 2007). Game theory and social choice theory are derivatives of rational choice theory (Hausman 2008). In the 1950s and 60s, the development of complex algorithms predicting individual choices facilitated widespread uptake of rational choice theory as a ‘universal theory of human behaviour’. The theory was taken up by American social scientists committed to using scientific approaches, as well as philosophers, mathematicians, operations researchers and computer scientists (Herfeld 2012). As such, rational choice became an “article of faith” among mainstream economists until the 1990s (Hodgson 2012). It is also the foundation of neo-classical economics (Shackley et al. 1996).

However, since the 1990s, the assumptions and predictive capacity of rational choice models1 have been widely disputed (including by six Nobel prize winners for Economics), particularly the notion that people consistently act in ways that maximise their rewards (Hodgson 2012). Scholars of behavioural economics have since recognised that people are driven by a much more complex suite of factors than that presented by rational choice theory (Foley & Griffiths 2011). Foley et al. (2011) quote behavioural economist Daniel Read, who points out that people:

…ignore important decision factors, put undue weight on some factors relative to others, plan to do the right thing but fail to follow through with those plans, they are more sure about their decisions or beliefs than they should be, they trust others more than they should, and they even fail to do simple calculations that could solve important problems. (p.21)

As the assumption of human rationality came under increasing fire in mainstream economics during the 1990s, rational choice theory was meanwhile gaining popularity in sociology, particularly with the rise of game theory (Hodgson 2012). Despite its critics, the ‘rationality’ of individual behaviour remains the unquestioned base assumption of contemporary economic analysis and is the “touchstone by which mainstream economists recognize each other” (Foley 2004, p.329). Policy-

1 Indeed the utility model of rational choice is not falsifiable and can be made to fit any given set of events, and is therefore highly limited in its applicability (Hodgson 2012).
making also continues to be largely premised on cost-benefit models of human decision-making derived from rational choice theory (Foley & Griffiths 2011).

### A4.3 Organisational Management

#### A4.3.1 Taylor and Scientific Management

At the turn of the 20th century, an American engineer named Frederick Taylor began looking at ways applying scientific methods to managing labour and production in industrial settings. In 1911, he devised his theory of Scientific Management, also now known as Taylorism (Schutt 2003). Taylor had a mechanistic and reductionist view of reality, and he equated people and organisations with machines (Jashapara 2004). His main concerns were economic efficiency and worker productivity, which he believed could be improved by dealing with them as scientific problems. As such, he aimed to replace to the worker’s individual judgement with ‘science’ (Schutt 2003). In doing so, he would observe the processes used to make a product, then break those processes down into their smallest possible parts. From these observations he would devise meticulously detailed plans of the work sequences needed for each sub-process, providing standardized descriptions of each activity, outlining the skills and time needed to conduct each sequence, and the quantities produced (Stacey et al. 2000). His work led to the introduction of several new elements to the work place, including time studies, divided foremanship, tool standardisation, planning departments, the concept of ‘tasks’, performance bonuses, and, most importantly, division of the workforce into a worker level and a management level (Schutt 2003). The worker was deemed unable to apply science to his work, due to “lack of education or through insufficient mental capacity” (Taylor 1911, quoted in Schutt 2003). Therefore the worker’s role was to ‘not think’ and simply do as instructed by management (Schutt 2003).

Taylor’s ideas were based on the notion of management as an objective science, and the belief that if a task was clearly defined and workers were given sufficient financial motivation, then the task would be efficiently performed (Stacey et al. 2000). His work led to the standardisation of work practices, transfer of production control from workers to management, the division of labour into simple tasks, and a move away from craftsmanship to mass production, automation, and cheap unskilled labour. Peter Drucker (1993) later viewed Taylor as the father of knowledge management, because deskillling of jobs was made possible by knowledge transfer achieved through scientific management. Expensive skilled workers were no longer needed as their skill, or knowledge, was built into the equipment and work processes. This had the effect of commoditizing labour, increasing competition between workers, and depressing wages and job security (Khurana 2009).

Scientific management had enormous influence on the manufacturing industries of the early 20th century (Drucker 1993). By the 1930s, however, scientific management had come under wide criticism for its simplicity and de-humanization of workers, and it became obsolete as a distinct practice. Nonetheless, its principles have seen continued application in management, military organisation and industrial engineering. Task-oriented work processes are now almost ubiquitous in industry, where the approach has been wildly successful. Scientific management is credited with a fifty-fold increase in productivity in industrialised countries over 100 years (Drucker 1993). In addition, corporate re-engineering, quality control and assurance, operations research and management, management cybernetics and total quality management all have their roots in scientific management (Khurana 2009).

#### A4.3.2 Druckerism – Management by objective

From the 1930s, the human relations movement had contested the scientific management view on worker motivation. They believed that workers form their own groups, customs and routines, and that managers would only succeed if they gained the respect of these groups (Stacey et al. 2000). From the 1940s to the 1960s, behavioural scientists built on these ideas, concluding that organisational efficiency was achieved when the values and goals of an organisation and its members were harmonised under high levels of trust. The focus of managers was thought to be garnering respect, cooperation and harmony when making and changing rules (Stacey et al. 2000).
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In the 1940 and 50s, Peter Drucker, a highly influential management consultant, set about finding an alternative to Taylor’s scientific management, one which fused capitalism and corporatism with American business practice (Waring 1991). During his youth in Austria, Drucker had been influenced by corporatist thinking of the Fascists. The corporatists were concerned about class conflicts engendered by industrial capitalism, which they believed could be overcome by establishing a “harmonious polity composed of functional economic groups, or corporations” (Waring 1991, p.207). Corporatists saw corporations as organic groups, whose goals were greater than the sum of that of their members, and therefore precedent. They believed that members would recognise that their needs were identical to that of the corporation, and therefore would automatically subordinate their personal needs to corporate goals (Waring 1991). While Drucker believed in strong authority and that economic goals must come before social ones, he also believed that managers had a responsibility to fulfil their employees’ needs (Waring 1991).

In 1949, Drucker coined the term ‘knowledge workers’ to describe those he saw as the new post-Taylorism skilled workers. These were the educated professionals, technicians and scientists, who produced ideas rather than things, applying their general skills and knowledge to unique work situations (Waring 1991). Because it was difficult to strip their knowledge from their person (and confer it onto machines and unskilled workers), knowledge workers had evaded the axe of Taylor’s scientific management and maintained a level of autonomy that manual workers no longer had (with the demise of craftsmanship and rise of mass production). This also meant that knowledge workers were difficult for management and bureaucracy (which had risen to significant power under Taylorism) to control and subordinate. In addition, the productivity of knowledge workers tends to be qualitative rather than quantitative, and therefore difficult to measure (Waring 1991).

Drucker responded to this threat much in the way that Taylor responded to unruly industrial craftsmen: by seeking ways to subordinate the knowledge worker to the goals and objectives of the organisation (Waring 1991). His intent was to harmonise the goals of the individual with the goals of the organisation by introducing management by objective and self-control. This approach involved top managers centrally determining organisational goals and strategy, while allowing knowledge workers a level of independence in making and implementing operational decisions aimed at achieving these goals. The system also involved measurement of performance against objectives, and systems of rewards and punishments. As was the case for Taylorism in the industrial age, Drucker’s management by objective (MBO) system became wildly popular among managers and academics in the decades that followed (Waring 1991). A 1974 survey of Fortune 500 companies found that nearly half the companies used Drucker’s system and viewed it as generally successful. However, few companies were found to actually use the method properly or in whole (often seeing participatory management as irrational and potentially anarchic), and it was unclear as to how it had been successful in terms of productivity etc. (Waring 1991). Many critics viewed Drucker’s approach, which called for separation of planning from work performance (splitting planning from doing), as a thinly disguised form of Taylor’s scientific management, in that it manipulated and objectified workers into instruments for reaching a management goal (Waring 1991). Levinson (1970) argues that in practice, worker self-control was largely illusory, that the MBO system was self-contradictory and did not meet worker’s needs. Waring (1991) quotes Levinson in this excerpt:

…the employee was forced to set personal goals within the confines of corporate strategy so that if he failed to reach them, he would be "hoisted on his own petard." Workers under these conditions felt "like rats in a maze" who only got to choose their own "bait." The underlying reward-punishment psychology only made things worse. Carrots and sticks caused employees to act less out of virtue and more out of selfishness; they were being bribed and bullied, not self-motivated. By treating people as "patsies to be driven, urged, and manipulated," management by objectives often intensified "the hostility, resentment and distrust" between manager and managed that it was supposed to eliminate and encouraged the withdrawal of efficiency that it was designed to overcome. (Levinson 1970, quoted in Waring 1991, p.226)

Other critics, such as Maslow (1965) argued that management by objective was premised on the assumption that people pursuing self-interest within an organisation automatically make good
choices and help others, thereby helping the organisation by virtue of this synergy. However, Maslow could only find evidence of this sort of behaviour in traditional Blackfoot culture. Waring (1991) concludes by arguing that Drucker's methods are premised on the same principles of scientific management in that they do not surrender managerial power and fail to synthesise planning and doing. Yet despite his critics, Drucker was to become one of the West’s most prolific and best-known management thinkers. He continued to influence management practice until his death in 2005.

A4.3.3 Organisational Development

Until the 1980s organisations were largely regarded as relatively static entities, at or near stable equilibrium, and flexibility and rapid responsiveness were not considered critical for their success (Levy 2000). From the 1950s to the early 1980s, planned approaches to organisational change, as pioneered by the organisational development movement and its founding father, the cyberneticist and social psychologist Kurt Lewin, dominated the management field (Burnes 2005). Lewin devised action research and group dynamics, which together with his theories of planned change are the foundations of organisational development (Smith 2001b). Action research involves iterative cycles of collaborative planning, acting, then reflecting on results (Figure A4.1); these cycles are essentially cybernetic in that they are intended to be self-regulating (Lewin 1946).

![Figure A4.1. The action research cycle.](image)

Planned approaches to organisational change focused on gradually improving organisational effectiveness using participatory team-based approaches (Burnes 2005). As was the case with Drucker's management by objective, reductionist methods were applied through the development of organisational objectives and outcomes, with different parts of the organisation incrementally dealing with separate problems and goals one at a time (Burnes 2005).

A4.3.4 Systems Dynamics

In the early 60s, the organisational sciences were widely influenced by the cybernetic work of Ashby (1964) involving system regulation via feedback loops, von Bertalanffy’s General Systems Theory (1969) and Forrester’s system dynamics (Forrester 1968). According to Burnes (2005), this led to conceptions of organisations as groups of black boxes connected by input and output loops, and eventually to Weick’s (1979) conception of organisations as loosely coupled systems governed by behavioural cycles linking peoples’ behaviours in feedback loops.

Systems dynamics is a field of research that started in the 1950s with the work of Jay Forrester, an American electrical engineer. After 15 years in science and engineering, where he conducted pioneering work in digital computers, Forrester chose to go into management, after developing a curiosity about fluctuating labour demands in a corporation (Forrester 1995). Upon investigating hiring and inventory protocols, Forrester was able to show that the corporation’s employment instability was the result of system oscillations caused internal decision-making rather than external business cycles. This marked the birth of system’s dynamics, a method for understanding the dynamic behaviour of complex systems (Forrester 1995).
According to Forrester (1991) system dynamics broadly applies theory, methods and philosophy to analyse the behaviour of different kinds of systems, including environmental, economic, social, engineering, and medical. In particular, systems dynamics examines how things change through time; it looks to understand the behaviour of dynamic and complex systems by examining the internal feedback loops, time lags, and stocks and flows that affect overall system behaviour. This is done using cybernetic feedback control concepts to organise information about systems into computer models (Forrester 1991). As such, the systems dynamics process involves a series of steps:

1. Identify a problem to be solved (situation that needs to be better understood, or a behaviour that needs to be changed).
2. Tap the knowledge and experience of those who are actively familiar with the problem.
3. Organise the available information into computer simulation models that employ feedback control and act out the roles of the people in the real system. (Forrester 1991)

With respect to step 2, Forrester emphasises the importance of tapping the real life knowledge of those in the working world, arguing that this data is much richer than the quantitative data that the social and management sciences have largely restricted themselves to. Forrester’s process echoes the participatory nature of Lewin’s action research approaches to organisational change, but differs in that the action cycle is played out in a computer simulation rather than the real world. Corporate modelling work done by Forrester in the 1960s went beyond looking at the effects of inventory, employment and production, to include the effects of subtle social considerations on management systems, such as the influence of top management, leadership, goal setting, and organisational traditions (Forrester 1995). He later applied his work to broader social systems in his work *Urban Dynamics* (1969) and *World Dynamics* (1971), which was later expanded on by Donella Meadows in her controversial book *Limits to Growth* (1972). Early systems dynamics work with corporations resulted in some key findings that carry over to other social systems:

First, most difficulties are internally caused, even though there is an overwhelming and misleading tendency to blame troubles on outside forces. Second, the actions that people know they are taking, usually in the belief that the actions are a solution to difficulties, are often the cause of the problems being experienced. Third, the very nature of the dynamic feedback structure of a social system tends to mislead people into taking ineffective and even counterproductive action. Fourth, people are sufficiently clear and correct about the reasons for local decision-making—they know what information is available and how that information is used in deciding on action. But, people often do not understand correctly what overall behaviour will result from the complex interconnections of known local actions. (Forrester 1991, p.9)

Meadows (1999) in her classic essay on how to create change in a system, identified 12 leverage points for intervening in a system—places where a small change can create a large shift in the system’s behaviour. These are listed below in ascending order of their relative strength or impact:

1. **Numbers**: constants and parameters such as subsidies, taxes, and standards
2. **Buffers**: the sizes of stabilizing stocks relative to their flows
3. **Stock-and-Flow Structures**: physical systems and their nodes of intersection
4. **Delays**: the lengths of time relative to the rates of system changes
5. **Balancing Feedback Loops**: the strength of the feedbacks relative to the impacts they are trying to correct
6. **Reinforcing Feedback Loops**: the strength of the gain of driving loops

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2 Donella Meadow’s and a team of collaborators devised a new model that expanded on Forrester’s work on *World Dynamics* (1971). The model was used to examine different possible patterns of world growth over two centuries, and their resultant environmental and economic outcomes. This work was presented in the 1972 book *Limits to Growth* (Meadows et al. 1972). With its predictions of economic collapse, the book generated a great deal rage for its suggestion that consumption and population growth needed to be curbed, and it was largely dismissed or attacked. However, events in the last 30 years have validated the books' predictions, and the model has since been updated (Meadows et al. 2004).
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7. Information Flows: the structure of who does and does not have access to information
8. Rules: incentives, punishments, constraints
9. Self-Organization: the power to add, change, or evolve system structure
10. Goals: the purpose or function of the system
11. Paradigms: the mindset out of which the system—its goals, structure, rules, delays, parameters—arises.
12. Transcending Paradigms

Meadows refers to Forrester’s observations that while the average business manager is able to intuitively and accurately guess where likely leverage points are in a system, more often than not they push the lever in the wrong direction, worsening the problem they are trying to correct. This is because leverage points are frequently counter-intuitive. She suggests that the only more powerful leverage point than a paradigm shift is the power to transcend paradigms, recognizing that no paradigm is ‘true’, and that every paradigm is “a tremendously limited understanding of an immense and amazing universe that is far beyond human comprehension” (Meadows 1999, p.19). She concludes by noting that the higher/more powerful the leverage point, “the more the system will resist changing it—that’s why societies tend to rub out truly enlightened beings” (p.19). Furthermore, she states:

Magical leverage points are not easily accessible, even if we know where they are and which direction to push them. There are no cheap tickets to mastery. You have to work hard at it, whether that means rigorously analyzing a system or rigorously casting off your own paradigms and throwing yourself into the humility of not-knowing. In the end, it seems that mastery has less to do with pushing leverage points than it does with strategically, profoundly, madly, letting go. (p.19)

Systems dynamics models continue to inform contemporary research on organisations (Burnes 2005). Notably, it was an important influence in Peter Senge’s conceptualisation of the learning organisation (Senge 1990), which is discussed in Section A4.5.10.

A4.3.5 Complexity Approaches to Management

Systems dynamics improved on previous approaches to understanding and managing organisations in three ways: 1) its emphasis on interaction and self-regulation; 2) identifying interconnections and indirect causal links distant in space; and 3) awareness that managers are part of the system and the importance of participation (Stacey et al. 2000). Although systems approaches were innovative in their conception of organisations as non-linear entities regulated through feedback, they fell down by continuing to treat organisations as closed systems near equilibrium and by failing to address the phenomena of spontaneous self-organisation—the emergent behaviour that characterises complex systems such as organisations (Stacey et al. 2000) (as per theories outlined in Appendix 3). However, by the late 1960s, organisational scholars began to seize on ideas from the newly emerging complexity sciences (Anderson 1999), both in terms of metaphor for gaining new insights into organisational behaviour, and as a means of mathematically modelling how organisations operate (Burnes 2005). For example, in 1967 Thompson described complex organisations as being wholes interdependent with their external environments and comprised of sets of interdependent parts (1967, cited in Anderson 1999).

Burnes (2005) notes that after 1970s’ oil shocks and Western economic recessions, the limitations of planned approaches for generating the rapid and radical organisational change needed to survive in a fast paced new world had become apparent. Thus, from the 1980s, management researchers began to conceptualise organisational change as a process of punctuated equilibrium3, as per challenges to Darwin’s gradualist model of evolution in the natural sciences, or as a process of continuous transformational change, as per ideas from the emerging complexity sciences (Burnes 2005). As a result, a number of new approaches to organisational change, which Weick (1979)

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3 Periods of gradual change punctuated by short periods of rapid transformational change.

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Complexity-based approaches that attempt to improve prediction and control of organisational behaviour are, however, criticised by Shackley et al. (1996) as simply constituting methodological extensions of more traditional systems-based approaches. Such approaches have likewise been criticised by Ralph Stacey, an economic modeller, management scientist and founder of the Complexity and Management Centre in the UK. In 1991, Stacey published the first in a series of books relating complexity sciences to organisations and management: The Chaos Frontier (1991). Stacey’s work challenges management research looking for ways to achieve stable equilibrium in organisations or finding more efficient means of controlling and designing organisations. He posits that such approaches are premised on Taylor’s scientific management and a Newtonian view of organisations as ‘mechanisms’—externally engineered self-regulating systems that can be studied to reveal the cause-and-effect laws that govern their behaviour (Stacey et al. 2000). He criticises this research as being largely reductionist, and premised on a false notion that organisations can be centrally controlled (2000). For example, he notes that the systems view of organisations typically assumes the presence of an observer or group of observers (i.e. managers or researchers) who delineate or design the organisational system, or who determine the rules of interaction for its component parts. This neglects the role of workers’ free choice in shaping the organisations. When the system does not work as designed, its members are stuck with it, making ordinary every day decisions to still get things done or work around it (Stacey et al. 2000). According to Stacey et al. (2000), this is why managers so often have the feeling of being in charge but not in control, and why the systems they design hardly ever work.

Stacey posits that the complexity sciences can provide a more coherent theoretical framework for understanding organisational behaviour (Stacey 1996; Stacey et al. 2000). He puts forward a complex responsive processes view of organisations, in which they are understood as self-organising, complex adaptive systems, as described in the works of selected complexity scientists, such as Prigogine (1984) and Kauffman (1993). In this view, an organisation is a living network, which, though somewhat constrained by its externally decreed structure, policies and plans etc. (its legitimate system), nonetheless consists of indeterminate, dynamic patterns of behaviours emerging through interactions of its members and with other systems (Stacey et al. 2000). Thus, contrary to the mainstream organisational thinking, uncertainty is inescapable and success can never be guaranteed; cooperation is more important than competition; no individuals, including managers, have the power to control or design organisational change; efficiency destroys organisational stability; diversity and conflict fosters innovation; potential success lies in co-existent stability and instability; and organisations are driven by their need to express identity (Stacey et al. 2000).

In direct contrast to the views of Stacey and Shackley, Burnes (2005) challenges the usefulness of viewing organisations as complex systems:

> If organisations are to be understood as dynamic non-linear systems capable of continuous transformation through self-organization, advocates of this approach will need to show either that it is more than just a metaphorical device, or that even as such it is able to resolve the problems of managing and changing organizations more effectively than other approaches that are on offer. (p.87)

Burnes also notes that a number of theorists doubt that complexity operates in organisations to the same extent it does in nature, and suggests that there is no evidence that mathematical models used

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4 Weick (1979) describes emergent change as the unplanned, unintentional adaptations and adjustments that organisational members make in their day-to-day work routines.
to describe the behaviour of complex systems in the natural world can be applied to human organisations. Others, such as Hull (1997) have criticised complexity theory application as just another management fad, or as a pseudoscience that undermines the credibility of the ‘real’ (i.e. positivist) complexity sciences (Phelan 2001).

**A4.4 Learning & Behaviour**

Learning can be simply defined as an enduring change in behaviour that results from experience or practice (Ertmer & Newby 1993). However, there are a number of differences in how learning theorists understand the learning process. These are associated with questions around how learning occurs, what influences it, and the role of memory, among others. Ertmer and Newby (1993) suggest there are three relevant theoretical perspectives on the learning process: behavioural, cognitive, and constructivist. Simply put, behaviourists view learning in terms observable behaviours and conditioning, cognitivists see learning in terms of information processing and creating mental models of reality, and constructionists view learning as a process of social interaction. In the following discussion, perspectives from selected authors within each of the three traditions are discussed (noting that there is cross-over). These authors were selected because of the influence of their work on the organisational learning concepts discussed in the following section, and the relevance of their work to the main body of this thesis, rather than the representativeness of their works to the three traditions of learning theory.

**A4.4.1 Behavioural Perspective: Deutero-learning & Double Binds**

Behavioural psychology, or behaviourism, as first defined in the 1930s work of Skinner and Gutherie, is focused on the form and frequency of observable behaviours, and behavioural modification via stimulus and response, conditioning, reinforcement and punishment (Jashapara 2004). In its more radical forms, behaviourism was only concerned with behaviour, and dismissed notions of inward thought and the internal workings of the mind5 (Hauser 2005). In so doing, however, it is unable to explain the experience of consciousness, for which it has been widely criticised. It was the principal branch of psychology in the West until the late it was overturned by the ‘cognitive revolution’ initiated by Chomsky (1959) in the 1950s, which led to cognitive approaches taking over as the dominant paradigm in psychology.

The concepts described below were developed or influenced by Gregory Bateson. Bateson was an anthropologist who was introduced to behaviourism in the 1930s by his wife Margaret Mead. This led to his interest in applying the results of behavioural experiments to culture and personality (Visser 2007). In the 1940s, Bateson became involved with the cyberneticists (see Appendix 1, Section A1.6.1), and Norbert Weiner became his mentor. From there he began to apply cybernetic and mathematical principles to learning and communication. His theories outlined below reflect Whitehead and Russell’s Theory of Logical Types (see Appendix 2), which Weiner, a prior student of Russell, had introduced to Bateson (Visser 2007). Bateson’s work differed from that of other behaviourists of the time by in that it focused on the dyad, the interaction involved in the behaviour, rather than on the individual behaviour itself (Visser 2007). Bateson was also responsible for developing the term vicious circle to describe situations where feedback causes a self-reinforcing series of events (2000).

The concept of deutero-learning was devised by Gregory Bateson in 1958 (Bateson 1958, 2000). Whereas proto-learning is the simple adaptation of behaviour in response to reinforcement, deutero-learning (otherwise known as Gestalt learning) occurs when behaviour changes as the result of insight about the context in which protolearning occurred (Visser). Deutero-learning has two key principles: 1) all living systems are capable of adaptive change via learning and feedback loops; and 2) all learning and change take place at the level of relationship and context, i.e. learning cannot be reduced to the individual level (Visser 2007). Individuals undergo deutero-learning when they modify their behaviour based on their experience of patterns of reinforcement and

5 In denying the existence of mental events, radical behaviourism is viewed as a rejection of Descartes metaphysical dualism in favour of materialism (Hauser 2005).
punishment in their dealings with others and the environment (Bateson 2000). In sum, deutero-learning is the largely unconscious “behavioural adaptation to patterns of conditions at the level of relationships” (Visser 2007, p.665). Because Bateson saw learning as occurring in the context of relationships, his thinking is considered to some extent to be consistent with constructionism (Littlejohn & Foss 2009).

Bateson also devised the double bind theory in the 1950s (Bateson 2000). This theory describes particular kinds of no-win situations where a person receives two conflicting messages, such that responding successfully to one message results in failure to respond to the other, creating a paradox. Peculiar to double-bind situations is the difficulty the victim has in discerning the exact nature of the paradox he or she is faced with. Examples of messages that lead to double bind situations are: “be spontaneous” or “I want you to want to study” (Watzlawick et al. 2011). Double-binds are frequently employed as a means of subtle control over others. Bateson viewed the double bind as a form of pathological learning (Visser 2007).

A4.4.2 Cognitive Perspectives

Whereas behavioural psychology traditionally viewed learning as a statistical change in behavioural response, cognitive psychology views learning as a change in states of knowledge (Jashapara 2004). Cognitive psychology is based on the notion that the mind operates very much as a computer. Its key assumptions are that mental processes are logically based on rules or algorithms in information processing models, and that the scientific method can reveal the mechanism of human cognition by studying individual components of mental processes (Zhong-Lin & Dosher 2007). Thus cognitive psychology applies an information processing perspective to learning (Jashapara 2004), one that assumes that people develop and use mental models that are more or less accurate pictures of reality.

The field of organisational learning is largely based on traditional cognitive approaches to learning. As such, the following sections introduce some key cognitive learning concepts that inform the field of organisational learning.

A4.4.2.1 Mental Models

Jones et al. (2011) provide the following overview of mental models in their interdisciplinary review of the concept. Mental models (sometimes referred to as schema), as first put forward by Craik (1943) are internal representations of a person’s external realities. They are equivalent to computational structures in a person’s working memory that allow them to explore and test different options in their minds prior to taking action. Mental models are constructed from a person’s life experiences and constitute ‘causal knowledge’ about phenomena; they are never fully complete or accurate, and they are also dynamic and context dependent. These mental models are used to instruct a person’s actions, which are viewed as separate and independent from cognition.

Learning occurs when one changes their mental models such that they are better able to explain or predict reality. However, mental models are subject to ‘confirmation bias’, in that people tend to preferentially seek information that fits their models, and may reject non-conforming information. Mental models are also limited in their capacity to consider feedback delays and indirect, knock-on effects of decisions (Jones et al. 2011).

A4.4.2.2 Espoused Theories vs. Theories in Use

The relationships between knowledge and action, and between conscious and unconscious reasoning, are fundamental aspects of work done by psychologist Chris Argyris and philosopher Donald Schöon (Argyris & Schöon 1974, 1996). Argyris and Schöon draw on psychoanalytic theory and the defensive mechanisms people use to protect themselves from unpleasant information to argue that people have two different theories of action that explain their behaviour: 1) the way people say they will behave in a given situation (their espoused theories), and 2) the way they actually behave (their theories-in-use). Often, there is a gap between these two theories of action:

When someone is asked how he would behave under certain circumstances, the answer he usually gives is his espoused theory of action for that situation. This is the theory of action
to which he gives allegiance, and which, upon request, he communicates to others. However, the theory that actually governs his actions is this theory-in-use. (Argyris and Schön 1974: 6-7)

In line with Craik’s (1943) concept of mental models, Argyris and Schön (1974, 1996) suggest that people’s theories-in-use are based on tacit ‘mental maps’ that govern their actions, often subconsciously. Argyris (1991) draws the following comparison:

[theory-in-use is] a set of rules that individuals use to design and implement their own behaviour as well as to understand the behaviour of others. Usually, these theories in use become so taken for granted that people don’t even realize they are using them. One of the paradoxes of human behaviour, however, is that the master program people actually use is rarely the one they think they use. Ask people in an interview or questionnaire to articulate the rules they use to govern their actions, and they will give you what I call their “espoused” theory of action. But observe these same people’s behaviour and you will quickly see that this espoused theory has very little to do with how they actually behave...put simply, people consistently act inconsistently, unaware of the contradiction between their espoused theory and theory-in-use, between the way they think they are acting and the way they really act. (p.7)

The subconscious nature of people’s theory-in-use is further explained by Argyris (1991) who states that these theories are developed early in life, and that the actions they produce are “highly skilled”, meaning their enactment requires little conscious attention. Because of this we are deeply unaware “of the programs in our heads that keep us unaware” (Argyris 1991). This ‘skilled incompetence’ and lack of awareness is counterproductive to true problem solving. People’s effectiveness is improved when their theories in use become better aligned with their espoused theories; this can be achieved through reflection (Argyris & Schön 1996).

Argyris and Schön (Argyris & Schön 1996) suggest that theories-in-use have three elements: 1) governing variables (the norms, values, objectives which people are trying to keep within acceptable limits), 2) action strategies (for keeping governing variables within an acceptable range), and 3) consequences (of action), both intended and unintended.

A4.4.2.3 Single vs. Double-loop learning

The theory-in-use is supported when the intended consequences of an action strategy materialise. When there are unintended consequences, there is a mismatch, and this is when learning takes place. Argyris and Schön (1996) suggest there are two possible responses when such a mismatch occurs: single-loop learning or double-loop learning. Single-loop learning occurs when people try to correct this mismatch by adjusting their actions without questioning their governing variables. The result is referred to as first order change, as described Watzlawick et al. (2011) (see Section A4.4.3). Double-loop learning occurs when people assess and alter their governing variables and change their underlying values. This result is referred to as second order change, also as per Watzlawick et al. (2011).

Argyris and Schön (1996) argue that single-loop learning that fails to change an individual’s values and assumptions is unlikely to result in real behavioural change. Indeed, Park (1999) notes that:

Often, improving the techniques of addressing the problem without changing the premises and the structures underlying the existing approach—characteristic of learning and change at the first-order level—runs into limits of efficacy and the problem continues to fester, if not worsen. (p.150)

Argyris and Schön (1996) observe that most people unconsciously hold theories-in-use that are “systematically counterproductive for double-loop learning, especially when the issues are embarrassing or threatening” (p.76). People are likely to view attempts to bring their attention to such counter-productivity as threatening, and typically resort to defensive reasoning and/or
avoidance as a consequence. If pressed on the topic, their defensiveness mounts, leading to new ‘distortions’ in their theory-in-use (Argyris & Schön 1996). As such, double-loop learning is very difficult to achieve in practice.

A4.4.2.4 Cognitive dissonance

The difficulty of achieving double-loop learning is explained in part by cognitive dissonance theory (Festinger 1957). When people are presented with new information that conflicts with their existing beliefs or behaviours, they experience an intolerable psychological discomfort termed ‘cognitive dissonance’. The mind quickly tries to eliminate this discomfort using one of two broad strategies: changing its beliefs and/or actions or resisting the new information. Most knowledge transfer efforts rely on the assumption that people will opt for the former strategy. However, research shows this is often not the case (Sides & Citrin 2007), and, perversely, presenting facts or correcting misinformation can actually reinforce people’s existing beliefs (Kuklinski & Quirk 2000; Nyhan & Reifler 2010). Indeed, some studies show that the more uninformed (Kuklinski & Quirk 2000), misinformed or ideological (Nyhan & Reifler 2010) people are, the more likely they are to adopt the latter position. This involves trivialising or avoiding the conflicting information, seeking additional support for existing beliefs, and discrediting the information source (Varela 1971). So although cognitive dissonance can lead people to change their beliefs and behaviours, it can also backfire, causing people to reject the new information, “shoot the messenger” and further entrench their positions. The ramifications of this polarising effect are widely seen in the climate change debate.

A4.4.3 Constructivist Perspective: Problem Formulation & Orders of Change

Cognitive perspectives on organisational learning are premised on the view that learning emerges through processing and responding to information via mental models, schemata or theories-in-use. This is based on a materialist or positivist view that assumes a real, independent world, that is external to the learner, about which knowledge can be acquired and mapped onto the learner’s brain (Ertmer & Newby 1993). Constructivists, however, come from an idealist perspective, which assumes reality is subjective and can never be truly known, as our experience of it is shaped by our minds. As such the constructivist viewpoint is a postmodern one. Constructivists view knowledge as something continuously created between learners through their social interactions and experiences (Ertmer & Newby 1993; Shotter 1994). Stacey et al. (2000) note that constructivist perspectives are premised on the work of social psychologists from the 1920s and 30s, namely Mead (1934), Vygotsky (1962) and Bakhtin (1986), who held the view that mind and self are not pre-existing—they emerge in social relationship, and are an internalisation of these relationships (Stacey et al. 2000).

Paul Watzlawick was a psychologist, philosopher, and radical constructivist, who followed the footsteps of Gregory Bateson (Bodin 2007). Watzlawick built on Bateson’s work and made a number of contributions to communication theory, which is based on cybernetic approaches to technical and human communication. In 1974, Watzlawick joined together with John Weakland and Richard Fisch to publish their classic book Principles of Problem Formulation and Problem Resolution (2011). In this work, the authors apply Whitehead and Russell’s Theory of Logical Types (1913), and Galois’ Group Theory (see Appendix 2) to therapeutic interventions.

Watzlawick et al. (2011) suggest that people are often faced with hierarchies of logical types (as per Whitehead & Russell 1913, see Appendix 2), and the puzzling consequences of confusing levels in these hierarchies. In their analysis of psychotherapeutic interventions, they found that most logical attempts to solve human problems either failed or caused the problem to worsen. The authors looked at the processes of persistence and change, and how these relate to problem formulation and resolution. From this they discovered that therapeutic approaches focused on creating first order change tended to result in problem perpetuation, whereas those focused on second order change tend to result in problem resolution.

According to Watzlawick et al. (2011), first order change is that which occurs within a given system, leaving the system unchanged. Second order change changes the system itself. The Theory of Logical
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Types indicates that this is because the world of experience is made up of interdependent opposites, from which reality derives substance. Translated into a cybernetic perspective, this means that the behaviours of a particular system are the result of a complex circular network of feedback loops that regulate the system and maintain homeostasis in the face of change (i.e. causal effects are circular rather than linear). Therefore, changing something into its opposite (opposites being of the same logical type, and therefore of the same system level) creates no overall change in the pattern of the system; rather it just feeds the system with more of the ‘same’. As such, attempting to change a system using first order change reinforces the system’s existing behaviour, and can actually escalate the problem by creating a vicious circle (Bateson 2000), or a Game Without End (Watzlawick et al. 1967), which in turn lead to conflict and conflict engendering ‘solutions’, such as arms races, etc. (Watzlawick et al. 2011). This phenomena is the basis of why people often feel like they are ‘banging their head against a wall’ when attempting to resolve personal or social issues.

According to the authors, second order changes are qualitatively different from first order changes. They appear contrary to common sense, and are often seen as “uncontrollable, even incomprehensible, a quantum jump, a sudden illumination,” sometimes even being interpreted as acts of grace (p.23). Although apparently mysterious when viewed from inside the system, second order change is simply a change in the rules or premises that govern the system as a whole (meaning change at a higher logical level). In cybernetics this is referred to as a step functional change. The authors metaphorically illustrate the kind of thinking required for second order change using the classic nine dot puzzle (Figure A4.2), where the player is asked to connect all nine dots using just four straight lines, without lifting pen from paper:

**Problem**

![Nine dot puzzle](image)

*Figure A4.2. The nine dot puzzle. Connect all nine dots using just four straight lines, without lifting pen from paper.*

Most people fail to solve the puzzle, because they make the assumption that the solution must be found within the square (i.e. the ‘system’); however the only way to solve the puzzle is to go outside of the square (Figure A4.3). Thus, Watzlawick et al. conclude “failure to resolve a problem doesn’t lie in the impossibility of the task, but in the attempted solution” (p.25). The solution can be found in examining the assumptions that govern the system as a whole, not in looking at the parts of the system, or the rules and assumptions that govern these individual parts (i.e. by examining the assumptions about the dots rather than the dots themselves). Trying to stop a vicious circle or a game without end requires whole system change. Trying to solve these types problems by implementing first order change either escalates the problem or IS the problem (Watzlawick et al. 2011, p.38).

Watzlawick et al. (2011) refer to three categories of problems. The first category includes problems only requiring first order change. The authors refer to these as difficulties, rather than problems. The solutions to difficulties are generally common-sensical, and do not require special problem solving skills. For example, the solution to feeling cold requires finding a way to warm up: turning up the heat, adding a layer of clothing, building a fire, etc. The second category of problems are those for which there are no realistic solutions, and therefore must be accepted and lived with. These problems are outside the individual’s control or extreme or utopian in nature (e.g. wanting to eliminate violence in society). The third category consists of problems that require second order change: impasses, deadlocks, Games Without End, and vicious circles. According to the authors, these problems are typically caused by “mishandling difficulties” (p.38) or trying to solve unsolvable problems. In other words, second order problems are created when people mishandle their
Solution

Figure A4.3. The nine dot puzzle solution. To solve the puzzle, the player must go outside the square.

Attempts to resolve the first two problem categories. Watzlawick et al. (2011) cite three conditions where such mishandling occurs:

1. When action is required but not taken
2. Action is taken when none required, or when resolution is impossible
3. An error in logical typing is committed—attempting first order change when second order change is needed, or vice versa.

Watzlawick et al. (2011) call people who perpetuate the first condition terrible simplifiers. They deny there is a problem or attack those who say there is one, tend to simplify complexities and see themselves as advocates for 'common sense' who stick to the facts. Those who perpetuate the second condition are referred to as utopians. Utopians set unrealistic objectives and seek solutions where there are none. They are often moral and righteous, and try to persuade others that things should be different; however, they can actually make a tolerable situation unbearable through their actions. Those in the third condition are caught within a paradoxical (i.e. double-bind) situation and are unable to discern what it is that is creating the paradox (Watzlawick et al. 2011).

Watzlawick et al. (2011) observed that second order change usually occurs spontaneously. People they spoke to who had effected second order change could not articulate how it was that they arrived at their interventions. Arduous analysis of the problem at hand creates only first order change. From their observation, the authors outlined these principles of second order change:

1. Second order change applies itself to first order attempts to solve the problem
2. Second order change always appears weird, unexpected or paradoxical
3. Second order change deals with situation here and now (what), not the presumed causes of the situation (why)
4. Second order change techniques transcend the self-referential nature of the attempted first order solution, and put the problem in a different frame (Watzlawick et al. 2011)

Watzlawick et al. (2011) suggest the fourth principle of re-framing a problem can be used to help achieve second order change. Reframing means conceptualising the problem at a ‘meta’ level, or a ‘meta-reality’, whereby the system whole is viewed from a different perspective. The authors emphasise that this meta-reality is a subjective not an objective reality, quoting Ardrey (1970, p.3): “A territory, for example, cannot exist in nature, it exists in the mind of the animal.” The authors note that what is ‘real’ is typically only what a large number of people have agreed to call real (i.e. it is subjective). However, after a time the agreement is forgotten and the agreed reality becomes reified into a fixed objective reality in the minds of the people. People categorise the objects and phenomena they encounter as a way of simplifying and making sense of the world’s complexity. However, these categories are mental constructs, they are of a different logical type than the actual objects they represent. To confuse our representations of reality with actual reality is an error in logical typing, the equivalent of believing the map is the territory (Korzybski 1958). Which is why people often fail to see a way out of a problem—they are caged within their own limited constructs of reality, their ‘little maps’ from which they do not stray (Bateson 2000; Watzlawick et al. 2011).
The authors suggest the following steps for formulating and resolving a problem in a therapeutic setting:

1. Clearly define the problem in concrete terms (ensure the problem is a problem, and that it is curable)
2. Investigate solutions attempted so far (these are likely first order solutions)
3. Clearly and concretely define the desired change (a vague desire, e.g. more happiness, indicates that the wrong question is being asked), ensure it is realistic, and apply a time limit for solving it.
4. Formulate and implement plan for desired change—this often involves paradoxical ‘symptom prescription’, such as having an insomniac force himself to stay awake. (Watzlawick et al. 2011)

The authors provide a number of examples where they successfully applied interventions using the methods outlined above (citing a 73% success rate within 3-6 months in a sample of 97 cases). They note however that the ‘Achilles’ heel of their approach is sufficiently motivating their patients to follow-through with their prescribed activities (Watzlawick et al. 2011, p.113).

Watzlawick et al. (2011) also discuss their principles of problem formulation and solution in relation to social systems. They note that differences in status and interest between members or groups in a social system often result in persistent stalemates, with which all parties are unhappy but unable to change. The authors also suggest that when different groups within a social system view themselves as separate but symmetric, the outcome will likely be rapid escalation of conflict. Problems also often arise when groups attempt reach a desired but vague goal, then fail to do so, or create more problems in its pursuit (Bateson 2000; Watzlawick et al. 2011).

A4.5 Organisational Learning – A Cognitive Perspective

The field of organisational learning is a branch of organisational theory that examines theories and models of how organisations learn and adapt. The term was first used in 1965 and its popularity has grown dramatically in recent years (Crossan et al. 1999). Organisational learning draws from a wide range of disciplines, including anthropology, management science, computer science, human resource management, cognitive psychology, sociology and strategy (Easterby-Smith et al. 2004; Jashapara 2004), and has been applied to a number of different domains, including information processing, bounded rationality, and product innovation (Crossan et al. 1999). As such, a general theory of organisational learning has yet to be developed (Crossan et al. 1999). The field of organisational learning predates the more recent related literature around knowledge management and learning organisations, and serves as a foundation for these emerging fields (Jashapara 2004).

The concept of organisational learning was rarely touched on in the organisational research literature until 1978, when Argyris and Schön published their first book Organizational Learning (1978). While initially received with confusion and ‘repugnance’, the concept has since gained wide currency, and the authors are now widely known as the ‘fathers of organisational learning’ (Argyris & Schön 1996). According to Argyris and Schön (1996), much of this shift can be attributed to businesses, governments and regions being caught up in a “global economy where the pace of competition is savage and swift” (p.xvii), and where failure to detect and respond to early warning signals has disintegrated not only companies but entire industries. By the 1980s, the business game had radically changed, and there was recognition of organisations being “caught up in the reciprocal transactions with the environments in which they are embedded” (p.xviii-xix). To survive in this turbulent world, organisations would have to wholly and continuously transform and produce new patterns of behaviour in response to the changes around them.

At the same time, the business and management, finance, manufacturing and strategic planning disciplines were developing sophisticated diagnostic methods (Argyris & Schön 1996). However, as these fields developed, practitioners began to realise that implementation of their methods and principles was a problem. As such, they began to turn to organisational learning to rethink their approaches. For example, strategic planning was rethought in terms of organisational change; many
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scholars now agree that for strategy to be operationalised, it needs to become “an active, iterative process involving whole organizations—hence, requiring organizational learning” (p.xvii). Argyris and Schön suggest that four questions are central to the organisational learning literature:

1. What is an organisation that it may learn?
2. In what ways, if at all, are real-world organisations capable of learning?
3. Among the kinds of learning of which organisations are, or might become capable, which ones are desirable?
4. By what means can organizations develop their capability for the kinds learning they consider desirable? (1996, p.xx)

Much of the scholarly, research-based literature concerns itself with challenging the first three questions, particularly in relation to:

1. Arguing that the very idea of organisational learning is “contradictory paradoxical, or devoid of meaning” (p.xx)
2. Accepting the notion of organisational learning, but doubting that real-world organisations actually engage in organisational learning, or are capable of it
3. Accepting that real-world organisations learn, but denying that organisational learning is always or ever beneficial. (Argyris & Schön 1996)

The following is an overview of some of the key concepts in the field of organisational learning. The focus of the discussion is on the work of Argyris and Schön, who extrapolated their ideas around individual learning to organisations, and the work of others who have built on their ideas.

**A4.5.1 Cognitive approach to organisational learning**

Argyris and Schön (1996) describe organisational learning as an “active process of organising which is, at root, a cognitive enterprise” (pp. 16-17). They view learning as signifying either a product (something learned) or a process that yields that product. Casey (2005) summarises organisational learning as a social process involving both action (behaviour change/adaptation) and cognition (knowledge creation), with intended outcomes being “change or an increased capacity to survive through the creation of knowledge” (p.136).

According to Argyris and Schön (1996), an organisation’s members are continually working to understand the organisation and how they fit into it. Each member has his/her own incomplete picture, or mind map, of the organisation’s theory-in-use. Members try to complete this picture by continually redescribing themselves in relation to other members as conditions change and members interact. The evolving mind map members collectively form becomes the organisation’s theory-in-use, from which the organisation’s actual behaviours emerge. As such, understanding organisational learning requires a focus on the active process of organising, rather than on the organisation as a static entity (as per Weick 1979).

According to Argyris, & Schön (1996) organizational learning occurs when individual members inquire into a problem (resulting from a surprising mismatch between an action’s expected and actual results) on the organization’s behalf. In order to qualify as organisational learning, the lessons from the inquiry process must:

1. Accompany changes in behaviour that indicate changes in the organisation’s theory-in-use (how the organisation represents knowledge)

---

6 An organizational inquiry may result in a number of lessons, including: interpretations of past successes and failures, links between actions and outcomes and future implications, likely demands of a shifting environment on future performance, analysis of the strengths and weaknesses of various strategies and systems, descriptions of conflict, means of obtaining desired futures, etc. (Argyris and Schön 1996, p.17).
2. Be embodied in the images of the organisation its members hold in their minds and/or be embedded in organizational artifacts, such as maps, memories, policies, programs, etc. (how the organization holds knowledge). (Argyris & Schön 1996)

Argyris and Schön (1996) refer to lessons that do not meet the above two criteria as ‘near misses’. For example, an organisation may gain new insight, but this insight may not be translated into action. Or individuals may adopt new thinking and behaviours, but these are not adopted by the wider organisation, or there is only a temporary change in the organisation’s theory-in-use—especially when the understandings of the change are held in the minds of only a few, and therefore disappears when they leave the organisations. The authors observe that organisational learning, as thus defined, can be difficult to determine, particularly in the case of emergent phenomena (p.18).

Lipshitz (2000) suggests that this view of organisations, as both representations of knowledge and as containers of knowledge, reflects a fundamental duality in organisational learning. As such, organisational learning is viewed as learning-in organisation (individual members of the organisation learn, via training, etc.), as well as learning-by organisation (learning that manifests in procedures, policy, culture, etc.). So although an organisation learns through its members, what it ‘knows’ is greater (and sometimes less) than the sum of what its members know (Argyris & Schön 1996).

This anthropomorphic view of organisational learning (it not being self-evident that organizations can learn) is a key aspect of Argyris and Schön’s conceptual framework (Lipshitz 2000). Lipshitz (2000) sees this as a paradox that raises the question: if organisations do indeed learn through their members, how is learning at the individual level transformed into learning at the organisational level? Lipshitz argues that metaphors comparing organisational to individual learning are misleading because individual learning is a cognitive process, whereas organisational learning is a process of social interaction.

**A4.5.2 Superstitious Learning & Competence Traps**

The value of learning is subjective: it depends on how we judge its validity. Argyris and Schön (1996) note that not all learning is productive or desirable. Indeed the objective of the learning activity may be reprehensible (e.g. the Nazis learned to become more efficient at sending prisoners to camps and the gas chamber), or the learning itself may be based on a premise that is false or unworkable. The latter case is sometimes the result of superstitious learning (Levitt & March 1988), whereby one confuses coincidence with cause and effect (e.g. assuming a rise in profits that occurs after a new policy is brought in is the result of the new policy, when it is actually the result of a coincident improvement in the markets). According to Levitt and March (1988), managers are drawn to superstitious learning because it reinforces their notions of managerial control, which are often contrary to fact and therefore mythical.

In addition, organisational learning that is valid when first applied may later create negative overall effects. This leads to what Levitt and March call the competence trap, whereby “an experience of perceived success leads an organisation to persist in a familiar pattern of thought and action beyond the time and conditions within which it yields successful outcomes” (p.19). So-called ‘webs of interest’ build up around familiar strategies and technologies, thereby perpetuating ‘dynamically conservative’ processes that reinforce adherence to past lessons, with organisational members often being attached to these patterns, even when they have long outlived their effectiveness (Argyris & Schön 1996). As such, it is important to be aware that while organisational learning can be productive, it can also be “invalid, unproductive, or even downright evil,” (Argyris & Schön 1996, p20), and that it may be difficult or impossible to distinguish which it will be.

Argyris & Schön (1996) describe three types of productive learning, or organisational inquiry:

1. Instrumental learning that leads to improvement in how organisational tasks are performed
2. Inquiry whereby organisation explores and restructures criteria and values by which it evaluates its performance
3. Inquiry whereby the organisation enhances its ability to learn as per 1 and 2.
A4.5.3 Organisational Single & Double-loop Learning

According to Argyris and Schön (1996) organisations undergo single-loop organisational learning when “members of the organization respond to changes in the internal and external environment of the organization by detecting errors which they then correct so as to maintain the central features of theory-in-use,” thereby permitting “the organization to carry on its present policies or achieve its present objectives” (p.18). As such, single-loop learning is a homeostatic process—it works to maintain the present form and functioning of the organisation, although sometimes to the detriment of its long-term survival. Many organisational development interventions are designed to bring about first order change, i.e. to improve existing patterns of functioning (Bartunek & Moch 1987).

In contrast, double-loop organisational learning occurs when error is detected and corrected in ways that involve modification of an organization’s underlying norms, policies and objectives (Argyris and Schön 1996), allowing it be reflexive and adapt to an uncertain environment. While single-loop learning tends to follow routines or pre-set plans, double-loop learning is a creative and often spontaneous process (Smith 2001). Lipshitz (2000) notes that double-loop learning is ‘messy’ in practice, and typically “appears as a thorough inquiry employing multiple perspectives, which persists until the problem is clearly understood,” and that the products of the inquiry may often be “unpleasant or threatening” (p. 472). Unsurprisingly, learning of the single-loop variety is much more common; it is also less risky for both the individual and the organization, and affords greater control (Smith 2001a). In addition, many organisations are fixated on action, and do not incorporate reflection into their learning cycles (Garratt 1990).

Easterby-Smith (2004) notes that Argyris and Schön’s significant contribution to organisational learning was to demonstrate that learning from both incremental change (single-loop learning) and radical change (double-loop learning) are necessary, while also creating forceful arguments that while single-loop learning is useful in relatively stable environments, it may be disastrous during periods of rapid market and/or technological change. In these unstable environments single-loop learning actually inhibits double-loop learning (Argyris & Schön 1974; Edmondson & Moingeon 1999), resulting in the need for organisational unlearning (Nystrom & Starbuck 1984), a concept detailed in Section A4.5.8 below.

A4.5.4 Model I & II Organisational Theories-in-Use

While espoused theories can vary widely among organisations, theories-in-use do not. Argyris et al. (1985) present two different models of organisational theories-in-use, which are outlined in Table A4.1. Model I is by far the most prevalent, and is consistently used irrespective of the type of organisation, or the race, gender, culture, education or social status of its members. Model I focuses on retaining control and appearing competent and right, whereas Model II focuses on sharing control and being competent through honest and open evaluation (i.e. via dialogue and reflection).

According to Argyris et al. (1985), because attempts to solve an organisation’s problems can be potentially embarrassing and threatening to its members, a counterproductive anti-learning pattern is often created in organisations using Model I learning systems. This pattern actually inhibits detection and correction of error and is characterised by “defensiveness, self-fulfilling prophecies, self-fuelling processes, and escalating error” (Argyris 1982, p.8). Defensive reasoning arises from people’s aspirations and fear of failure and embarrassment. This leads to defensive routines in organisations, whereby “any action, policy or practice that prevents organizational participants from experiencing embarrassment or threat and, at the same time, prevents them from discovering the causes of the embarrassment or threat” (Argyris 1999, p.129).

In contrast, organisations with Model II learning systems do not bypass or cover-up error, embarrassment or threat, therefore allowing reflection and true learning to occur (Argyris 1999). For example, Jashapara (2004) suggests that failure may be prerequisite to organisational learning: he argues that errors occur on daily basis in organisations, and if these are not ‘harvested’—i.e. shared with colleagues, appraised and discussed as lessons—costly mistakes will tend to recur. He
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also suggests that rewarding success and denying failure tends to maintain the status quo and short-term stability, as people tend to stick to tried and true methods that can lead to complacency and aversion to risk and experimentation.


<table>
<thead>
<tr>
<th>Model I theory-in-use characteristics</th>
<th>Model II characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governing values are:</td>
<td>Governing values include:</td>
</tr>
<tr>
<td>Achieve the purpose as the actor defines it</td>
<td>Valid information</td>
</tr>
<tr>
<td>Win, do not lose</td>
<td>Free and informed choice</td>
</tr>
<tr>
<td>Suppress negative feelings</td>
<td>Internal commitment</td>
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<tr>
<td>Emphasize rationality</td>
<td></td>
</tr>
<tr>
<td><strong>Primary strategies are:</strong></td>
<td><strong>Strategies include:</strong></td>
</tr>
<tr>
<td>Control environment and task unilaterally</td>
<td>Sharing control</td>
</tr>
<tr>
<td>Protect self and others unilaterally</td>
<td>Participation in design and implementation of action</td>
</tr>
<tr>
<td><strong>Usually operationalized by:</strong></td>
<td><strong>Operationalized by:</strong></td>
</tr>
<tr>
<td>Unillustrated attributions and evaluations e.g. “You seem unmotivated”</td>
<td>Attribution and evaluation illustrated with relatively directly observable data</td>
</tr>
<tr>
<td>Advocating courses of action that discourage inquiry</td>
<td>Surfacing conflicting views</td>
</tr>
<tr>
<td>Treating ones’ own views as obviously correct</td>
<td>Encouraging public testing of evaluations</td>
</tr>
<tr>
<td>Making covert attributions and evaluations</td>
<td></td>
</tr>
<tr>
<td>Face-saving moves such as leaving potentially embarrassing facts unstated</td>
<td></td>
</tr>
<tr>
<td><strong>Consequences include:</strong></td>
<td><strong>Consequences should include:</strong></td>
</tr>
<tr>
<td>Defensive relationships</td>
<td>Minimally defensive relationships</td>
</tr>
<tr>
<td>Low freedom of choice</td>
<td>High freedom of choice</td>
</tr>
<tr>
<td>Reduced production of valid information</td>
<td>Increased likelihood of double-loop learning</td>
</tr>
<tr>
<td>Little public testing of ideas</td>
<td></td>
</tr>
</tbody>
</table>

Argyris and Schön (1996) state that overcoming defensive routines to shift away from a Model I theory-in-use may require an intervention. This involves mapping the problem as organisational members see it, having members internalise the map through inquiry and confrontation, and developing and testing new solutions. However, Argyris and Schön’s models and intervention phases have been criticised for being too ‘bipolar’ and too linear (Smith 2001a), and overly reliant on minimizing political behaviour, given organisations are inherently political (Easterby-Smith & Araujo 1999). Lipshitz (2000) also notes that while the work of Argyris and Schön is frequently referred to in a superficial manner, it has had a relatively small actual impact on the field in terms of practice. He attributes this to the difficulty involved in surfacing interpersonal theories-of-action and shifting an organisation from Model I to Model II learning:

Letting go of deeply ingrained Model I norms of achievement, control, and suppression of ill feelings is extremely difficult even under the most skillful guidance. Argyris and Schön’s writings are full of examples of clients who espouse Model II values but fail to produce behavior consistent with them…because they [double-loop learning and Model II organizations] are so difficult to realize, at both the individual and organizational levels, these concepts can rarely be observed. (Lipshitz 2000, p. 470-471)

Attempting an intervention to shift and organisation away from Model I learning requires considerable mastery and experience on the part of the interventionist (Lipshitz 2000), and extraordinary skills in managing difficult interpersonal interactions (Edmondson & Moingeon 1999).

According to Lipshitz (2000) another key premise of Argyris and Schön’s conceptual framework is the preposition that “stable solutions are inappropriate criteria for organizational learning since solutions to organizational problems typically create new problems,” (p.460). The notion that stable solutions breed new problems, underlines frequent observations that large-scale organisational change requires a crisis (Allison & Hobbs 2006; Bartunek & Moch 1987; Nystrom &
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Starbuck 1984). Lipshitz elaborates on this point, stating, “in dynamic environments solutions are short lived,” (p.463). He argues that rather than learning to solve particular problems, it is more important for organisations to “create conditions that facilitate people’s ability to detect and correct problems,” (p.463), i.e. meta-learning, which is discussed in Section 5.6.

4.5.5 Organisational learning mechanisms

Lipshitz (2000) and Popper and Lipshitz (1998) argue that Argyris and Schön’s theory of organisational learning is problematic, in that it fails to specify how individual learning translates into learning at the organisational level, or how managers can induce organisational learning in real life. The authors note that while humans clearly follow an experience, reflect, conceptualise, and memorize learning cycle, it is unclear whether or not organisations are in possession of such cognitive abilities, or whether in fact they can learn at all. As such, Popper and Lipshitz outline a number of arguments in the literature for and against organisational learning being treated as an extension of individual learning, namely:

1. Organizations have cognitive systems enabling them to perceive, think, reflect, and so on, which are similar to those possessed by individuals
2. Organizations do learn, but mediated via the learning of their individual members
3. Similar to individuals, organizations are capable of learning; however, the individual learning and organizational learning differ fundamentally
4. Organizations and their members often know, or come to know, different things (organisations may know more or less than their individual members). (p.163-165)

Popper and Lipshitz (1998) suggest that two types of organisational learning must be distinguished: learning in organisations and learning by organisations. Argyris and Schön (1996) refer to this as the ‘paradox of learning’, whereby organisational learning is greater than the sum of individual learning, but can only occur through the behaviours and experience of its individual members.

Popper and Lipshitz (1998) attempt to resolve this dilemma by introducing the concept of organisational learning mechanisms (OLMs): the structural and procedural arrangements whereby learning by an organisation’s individual members is followed by changes in the organisation’s behaviour patterns. This approach relies on concrete observations rather than hypothetical constructs about how organisations learn. Popper and Lipshitz argue “a collective becomes an organization once it develops procedures and structures (e.g., voting rules and management systems) that allow it to act as a unit,” (p.170). These procedures and structures serve as analogues to the human nervous system, allowing the organisation to learn by gathering, storing, analysing and distributing information relevant to its performance (Popper & Lipshitz 1998).

Popper and Lipshitz also suggest that OLMs can be integrated or non-integrated. Integrated OLMs are tightly synched with (and often indistinguishable from) job performance and are operated by those actually doing the job. They use the example of the Israeli Air Force, which routinely carries out after-action reviews, involving an unflinching group dissection of every member’s performance. In contrast, non-integrated OLMs are not integrated with job performance, and are typically conducted by specialist staff (e.g. research and development units). While non-integrated OLMs are easier to achieve, they produce a lower level of learning relative to integrated OLMs. In addition to their structural aspect, OLMs also have a cultural aspect—the shared values and beliefs that contribute to learning (such that actual learning occurs, rather than just the ‘ritual’ of learning) (Popper & Lipshitz 1998).

Popper and Lipshitz (1998) suggest that creating learning organisations requires structural and cultural changes. Based on their study on the Israeli Air Force, they propose the following: change the organisation (structures and processes) and its members (their values/culture), provide members with ‘elbow room’ (create commitment and space to learn), and learning by doing and joint experimentation (do not rely on grand plans, realise failure is a possibility). Popper and Lipshitz also identify four factors that improve the likelihood that OLMs will be embedded in an
organisational’s learning culture: environmental uncertainty, criticality of error, members’ professionalism, and committed leadership.

### A4.5.6 Meta-learning in organisations

Argyris and Schön (1996) also describe a third form organisational learning after the work of Bateson (2000)—deutero-learning, or learning how to learn. Argyris and Schön’s conception of deutero-learning is fundamentally different from Bateson’s original notion of the term (Section A4.4.1); it involves thinking about ways to improve organisational performance by reflecting on the processes in which single and double-loop learning occur. Argyris (2003) later re-worked their concept of deutero-learning into that of meta-learning. Meta-learning is also akin to the notion of third order change (Bartunek & Moch 1987), discussed in Section A4.5.11.

Visser (2007) compares Bateson’s notion of deutero-learning with Argyris’ concept of meta-learning. According to Visser, whereas deutero-learning is unconscious, resistant to steering, and not necessarily conducive to organisational improvement, meta-learning is conscious, amenable to steering, and aimed at improving organisational performance.

Visser (2007) suggests that deutero-learning can be pathological, and has important implications for organisational theory in terms of self-fulfilling prophecies, interpersonal interaction, climate formation, and learning pathologies such as double binds. Whereas deutero-learning is not amenable to managerial efforts to improve organisational performance, meta-learning provides a more optimistic view and suggests that it is possible to improve organizational problem solving and learning through reflection and inquiry (Visser 2007). Visser then introduces his notion of planned learning, whereby meta-learning processes and systems are embedded and maintained within the organisation. He describes it as the “creation and maintenance of organisational systems, routines, procedures, and structures through which organisational members are induced to meta-learn on a regular basis and in which the results of meta-learning are embedded for future use,” (p.665).

### A4.5.7 Organisational Routines & Dynamic Capability

Jashapara (2004) notes that organisational routines are important part of organisational learning because they link an organisation’s structures and processes with its actions. According to Jashapara, organisational routines were originally viewed as regular, predictable and repeated patterns of behaviour in organisations, embedded in organisations’ culture, beliefs and frameworks. They were seen to include the organisation’s rules, policies, norms, conventions and day-to-day behaviours, which rolled out mechanically, like a computer program, from the organisation’s operating procedures. Organisational routines were thought to outline staff turnover and viewed as a source of organisational stability/inertia. Cohen and Bacdayan (1994) make the argument that organisational routines are stored in an organisation’s procedural memory—the tacit, unconscious ‘know how’ associated with its members skilled actions—rather than its declarative memory, which constitutes the organisation’s repository of facts and events (its ‘know what’). As such, organisational routines are essentially habits which are difficult to articulate and largely automatic. In this view, organisational routines can be seen as the manifestation of an organisation’s theory-in-use (Argyris & Schön 1996). A different ‘grammar model’ view is presented by Pentland and Rueter (1994), who see an organisational routine as a set of possible patterns, the number being constrained by various social, physical cognitive and organisational structures. In this view, organisational members use a limited set of possible routines to accomplish a particular task, with no particular outcome in mind (Pentland & Rueter 1994).

The notion of dynamic capability is related to that of organisational routines, in that it relates to ‘routines to learn routines’ (Jashapara 2004), similar to ideas around meta-learning (Argyris 1983, Visser 2007). According to Jashapara (2004), organisational routines and accumulated tacit knowledge serve business well in stable environments and market conditions. However, in volatile, rapidly changing environments they can be detrimental in that they can inhibit learning and adaptation to new circumstances. Dynamic capabilities, on the other hand, enable business to adopt new routines and adapt to new circumstances. They are composed of simple, flexible routines with few rules (Jashapara 2004).
Appendix 4

A4.5.8 Organisational Unlearning

The counter-intuitive notion of organisational unlearning was first developed by Hedberg (1981), and demonstrated by Nystrom and Starbuck (1984), whose research showed that people in organisations often continue to apply old schemata in ways that can precipitate serious crisis. Central to their arguments is the notion that learning in organisations is primarily about destabilisation and that old learning inhibits new learning:

Organizations learn. Then they encase their learning in programs and standard operating procedures that members execute routinely. These programs and procedures generate inertia, and the inertia increases when organizations socialize new members’ and reward conformity to prescribed roles. As their successes accumulate, organizations emphasize efficiency, grow complacent, and learn too little. To survive, organizations must also unlearn...[b]efore organizations will try new ideas, the must unlearn old ones by discovering their inadequacies and then discarding them. (Nystrom & Starbuck 1984, p53).

In sum, organisations are unable to adopt second or third order change without first unlearning their old schemata; for learning to occur, it must be accompanied by unlearning. Nystrom and Starbuck (1984) highlight numerous cases where managers’ previous learning aggravated crises. The authors argue that this is why organisations in crisis tend to remove their top managers—to eliminate the domination of their ideas. They found top managers in struggling companies often fail to detect or predict crises, cling to faulty beliefs and strategies (schemata) that are no longer working, rationalise their failures, and fail to see potential opportunities. When the managers finally recognised a crisis, they often pursued storm weathering strategies such as: liquidating assets, postponing investments, reducing maintenance, halting training, centralising decision-making, raising prices and leaving positions vacant (Nystrom & Starbuck 1984). Managers in crisis situations were also seen to have an over-reliance on changing accounting procedures to conceal the symptoms of the looming crisis. According to Nystrom and Starbuck, these superficial strategies may provide temporary respite by making the books look better, but they do not cure the organisation’s problems. Rather problems inevitably re-sprout, and then have to be solved by an organisation stripped of staff and resources. They note that organisational crises are common, with only 10% of US corporations surviving 20+ years and similar rates for federal US agencies (Nystrom & Starbuck 1984).

Nystrom and Starbuck (1984) argue that simply having knowledge that alternative organisational schemata may create better results will not on its own cause an organisation to abandon its old schemata. The organisation needs strong evidence that their existing schemata are deficient before they will engage in second order change—the kind of evidence provided by ongoing crises, escalating dissension, conflict, and loss of confidence in the organisation’s leaders. As such, organisational learning may be function of destabilisation (Hedberg et al. 1976).

Nystrom and Starbuck (1984) argue that most organisational failures are avoidable. They suggest that some people in the organisation will be able to predict or see a crisis, whereas others cannot, depending on their respective cognitive structures, or schemata. They also found that the managers they studied never saw their past learning as an impediment to detecting or recovering from a crisis. They also found managers used defensive routines that blocked crisis warning signs, such as silencing subordinates and dissenting messages from below, and surrounding themselves with ‘yes-men’. As a result, recovery from a crisis usually requires changes in top management, accompanied by major cognitive shifts in organisational strategies. Nonetheless, Nystrom and Starbuck suggest that managers can avoid this fate by stimulating their own learning and unlearning via: listening to dissenters, converting events into learning opportunities, and adopting experimental frames of reference.

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7 Crisis being defined as a situation that seriously threatens an organisation’s survival (Nystrom & Starbuck 1984).
A4.5.9 Exploration vs. Exploitation

Many parallels from the above discussion can be seen in organisational learning studies that examine adaptive processes involving the exploration of new possibilities versus exploitation of old certainties (March 1991). March (1991) sums up exploration as being featured by “search, variation, risk taking, experimentation, play, flexibility, discovery, [and] innovation,” (p.71), the returns of which are “uncertain, distant, and often negative” (p.85). As such, exploration can be seen as a process that involves double-loop learning. He goes on to summarize exploitation as being characterised by: “refinement, choice, production, efficiency, selection, implementation, [and] execution,” the returns of which are “positive, proximate, and predictable” (p.85). Thus, exploitation can be seen as involving single-loop learning. March argues that the long-term survival of adaptive systems (e.g. organisations) requires appropriate trade-offs between explorative and exploitative behaviours. Those organisations that are overly focused on exploration will suffer the costs of experimentation with minimal benefit, whereas those that are overly focused on exploitation will become “trapped in suboptimal stable equilibria” (p.71). Because exploration involves a greater uncertainty and a greater time gap between learning and realization of returns, adaptive systems will often preferentially engage in exploitation of known alternatives (March 1991).

March (1991) suggests that there are two important features of the social context in which organisational learning takes place. The first is mutual learning by the organization and the individuals within it. Organisations learn from their members, storing the garnered knowledge in policies, procedures, rules and norms. Concurrently, organisations’ members become socialized to organisational beliefs. Over time, an organisational code develops, which in turn affects the beliefs of its members, while the organisation also is being affected by the beliefs of its individual members. The second is competition for primacy, whereby organizations compete with each other for relative standing –knowledge has been shown to have a variable effect on this standing.

Interestingly, Holmqvist (2004) found that learning within organizations tended to bring about exploitative learning, whereas learning between organizations tended to bring about explorative learning. Crossan et al. (1999) present the notion of strategic renewal, whereby organizations explore and learn new ways of doing things, while also exploiting what they already know. Most of the innovative thinking in this framework occurs via intuitive and subconscious pattern recognition among its members (Crossan et al. 1999).

A4.5.10 Learning Organisation

Whereas Argyris and Schön’s work on organisational learning (1974, 1996) focuses on the interactions of individuals within a group and their defensive routines, Peter Senge’s (1990) work on learning organisations has an additional focus on systems and structures, derived from Jay Forrester’s work on systems dynamics (1968, 1969; 1975; see Section A4.3.4). As such, Senge’s learning organisation concept draws together organisational learning and systems thinking, and looks at the inter-relationships between an organisational system’s parts to better understand the whole. Whereas organisational learning focuses on objective analysis of the processes of individual and collective learning within organisations, the literature on learning organisations is action focused, and assesses the effectiveness of tools that can be used to foster learning within organisations (Easterby-Smith & Araujo 1999).

The learning organisation is based on the notion that in order to be competitive and successful in unpredictable environments, businesses must be able to continuously learn and quickly transform their learning into action (Senge 1990; Senge et al. 1999)—i.e. they must be flexible and adaptive. According to Senge (1990), in order to shift to a learning organisation, organisational members need to master five ‘disciplines’:

1. understanding systems dynamics
2. achieving personal mastery through continuous learning
3. overcoming entrenched mental models through reflection
4. building shared vision
5. Team learning.

While all people have the capacity to learn, often they are confined within organisational structures that do not foster reflection and engagement with others, thereby inhibiting double-loop learning. Senge sees people in organisations as agents having the capacity to shift from being “helpless reactors” to “active participants” in shaping their reality and the future (Senge 1990, p.69). In mastering these five disciplines Senge places a strong emphasis dialogue, or conversation, as conceived by David Bohm (Bohm et al. 1991). Smith (2001c) describes Bohm’s approach as being one whereby a group becomes open to the flow of a larger intelligence, and thought is approached largely as collective phenomenon. Conversation in this case can be is meant to advance mutual understanding and well-being rather than to ‘win the argument’ (Smith 2001c).

According to Peter Senge (1990) learning organizations are “organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together,” (p.3). Team learning is dependent on the capacity of a group to engage in dialogue and discussion. Senge further notes:

When you ask people about what it is like being part of a great team, what is most striking is the meaningfulness of the experience. People talk about being part of something larger than themselves, of being connected, of being generative. It becomes quite clear that, for many, their experiences as part of truly great teams stand out as singular periods of life lived to the fullest. Some spend the rest of their lives looking for ways to recapture that spirit. (p.13)

Senge et al. (1999) identify a series of ten challenges faced by any innovative group which begins to conduct its work in unfamiliar ways. They suggest there are unique challenges to different stages of any organisational change initiative: the initiating stage, the sustaining stage, and the redesigning and rethinking stage (Table A4.2). These common barriers largely relate to institutional inertia arising from systemic social processes working to maintain the status quo. Senge et al. (1999) regard these challenges, or barriers, as natural limiting processes representing the “homeostatic forces of industrial-age organizations” (p.26). They observe that innovators’ strategies fail because they focus on their innovations rather than on “understanding how the larger culture, structures and norms will react to their efforts,” (p.26); i.e. how and why the larger organisational system will push back. As such, Senge et al. argue that innovators must recognize and accept organizational homeostatic forces then generate systemic strategies to tackle these challenges and achieve sustained organizational change.

Smith (2001c) notes that a number of criticisms have been levelled at Senge’s learning organisation concept in relation to its applications for modern profit-focused organisations. These include charges that real-life examples of learning organisations are lacking, and that focusing on learning and development is too idealistic for most companies and employees (Jashapara 2004; Smith 2001c). The lasting contribution of this model has been the use of dialogue in team learning and the importance of systems thinking in understanding organisational dynamics (Jashapara 2004).

A4.5.11 Organisational Development & Orders of Change

Bartunek and Moch (1987) propose that cognitive approaches to organisational learning can also be applied in the field of organisational development. They build on Markus and Zajonc’s (1985) notion that Argyris and Schön’s (1996) theory-in-use concept is similar or identical to the notions of schemata and cognitive maps as they are used in cognitive science, as well as Kuhn’s (1962) concept of paradigms. Bartunek and Moch propose the concept of organisational schemata, which are shared meanings or frames of reference negotiated by members of organisations. The authors describe organisational schemata as social (in that they are collectively created and maintained), enduring, and inequitable (in that they do not equally serve the interests all organisational members.
### Table A4.2. Challenges to generating profound organisational change (Senge et al. 1999).

<table>
<thead>
<tr>
<th>Challenges to Organisational Change</th>
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<tbody>
<tr>
<td><strong>Initiating Stage</strong></td>
</tr>
<tr>
<td>Not enough time (time gap)</td>
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<tr>
<td>• People involved in change initiative have inadequate time for reflection and practice</td>
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<tr>
<td>No help (help gap)</td>
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<tr>
<td>• Inadequate coaching, guidance, and support for innovating groups</td>
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<tr>
<td>Not relevant (commitment gap)</td>
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<tr>
<td>• Difficulty making a case for change, showing why new efforts are relevant for business goals</td>
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<tr>
<td>Not walking the talk (trust gap)</td>
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<tr>
<td>• Mismatch between behaviour and espoused values, particularly among those championing change</td>
</tr>
<tr>
<td><strong>Sustaining Stage</strong></td>
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<tr>
<td>Fear and anxiety (openness gap)</td>
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<tr>
<td>• Concerns about exposure, vulnerability and inadequacy</td>
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<tr>
<td>Assessment and measurement (results gap)</td>
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<tr>
<td>• Disconnect between organisation’s traditional way of measuring success and achievements of change initiative</td>
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<tr>
<td>Believers and nonbelievers (engagement gap)</td>
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<tr>
<td>• Isolation and arrogance of innovating group piloting the change initiative</td>
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<tr>
<td><strong>Redesigning/Rethinking Stage</strong></td>
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<tr>
<td>Governance (integration gap)</td>
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<tr>
<td>• Conflicts between innovating groups seeking greater autonomy and managers concerned about autonomy leading to chaos and internal fragmentation</td>
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<tr>
<td>Diffusion (diffusion gap)</td>
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<tr>
<td>• Inability to transfer knowledge across organizational boundaries</td>
</tr>
<tr>
<td>Strategy and purpose (reinvention gap)</td>
</tr>
<tr>
<td>• Difficulties with revitalizing and rethinking organizations intended business focus, contributions and community</td>
</tr>
</tbody>
</table>

Bartunek and Moch refer to Nystrom and Starbuck’s (1984) work showing that people in organisations often continue to apply old schemata even when they are no longer useful, and suggest that this is synonymous to single-loop learning and Model I learning systems (Argyris & Schón 1996), and Watzlawick et al.’s (2011) concept of first order change. Building on Watzlawick et al. (2011), Bartunek and Moch argue that, in relation to organisational development, planned change efforts can create three orders of schematic change in an organisation:

- First order change: the tacit reinforcement of present understandings
- Second order change: the conscious modification of present schemata in a particular direction
- Third order change: the training of organisational members to be aware of their present schemata so they are more able to change these schemata as they see fit.

First order schematic change is clearly an outcome of single-loop organisational learning, and second order change, whereby the old set of schemata are exchanged for another, is an outcome of double-loop learning. However, the authors’ conception of third order change takes things a step beyond Watzlawick et al.’s (2011) two orders of change, and relates back to Argyris’ (2003) concept of meta-learning.
Bartunek and Moch (1987) note that many organisational change agents do not have a cognitive perspective that enables them to understand how to successfully target their interventions (i.e., are they aiming for first, second or third order change?), or how their own schema (e.g. increased employee participation is good) may conflict with those of the organisations they are working with (e.g. participation is costly and threatening). According to Bartunek and Moch, the change agent must consider whether first, second or third order change is required. For example if the organisational schemata simply needs adjustment or improvement, the role of the change agent will be to bring about first order change. If the organisational schemata is no longer working, the change agent will need to focus on changing this schemata (second order change) by creating a commitment to change among management and employees. This will require a ‘reasoned judgement’ on the part of the change agent, in terms of what kind of schemata would be best for the recipient. It also requires an ethical judgement, because second order change will benefit some and disadvantage others. If third order change is desired, then the change agent needs to take on a teaching role, with a focus on training and empowering recipients to recognise and assess their own schemata and create second order change as needed. In this case, the organisational members, not the change agent, take on the reasoning and ethics involved in bringing about second order change (Bartunek & Moch 1987).

Because these approaches require different and possibly conflicting roles, it is important for the change agent to clarify the necessary approach, identify and appreciate the schema held by members of the organisations (e.g. participatory, paternalistic or managerial control), and be aware that he/she may have to make reasoned and difficult ethical decisions (Bartunek & Moch 1987). Depending on the order of change targeted, Bartunek and Moch suggest the change agent, and possibly organisational members, may need training in methodologies for identifying schemata, such as analysing language and stories, changing people’s routines and guided group reflection. Training in methodologies for inducing first, second and third order change would also be required (e.g. encouraging first order change by introducing proposed changes as a useful extension of the organisation’s existing practices, rather than as a new endeavour), recognizing that agents will not be able to change organisational members’ schemata simply by telling them to do so (Bartunek & Moch 1987).

However, in their literature review, Bartunek and Moch note that most second order change is achieved by “natural rather than planned means” (p. 495), and often occurs in response to a crisis that ‘unfreezes’ the existing schemata of the organisation. This crisis can be experienced naturally or be induced by the change agent, e.g. by prescribing actions that cannot be effectively implemented by the existing schemata, or alerting those not benefiting from the existing schemata that their interests are not being served. To prevent fall back into the old schemata, it is essential that the change agent demonstrates and advocates alternative schemata, meaning he or she cannot remain neutral in the process. The change agent also needs to be prepared for the uncertainty and conflict that often characterise second order transitions. This includes unplanned processes and outcomes, as what was intended may not materialise once change is set in motion. For third order change, the agent fosters awareness of alternative schemata, but does not advocate. Rather the agent enables organisational members to assess these alternatives against their existing schemata. Strategies for achieving this are not well developed but could include introducing different groups and departments to share perspectives on different ways of understanding and resolving problems (Bartunek & Moch 1987).

Bartunek and Moch conclude by noting their research raises some important questions, notably:

1. Is success at lower orders of change required for a system to develop toward higher order change?
2. Must change agents master skills needed for lower order change before trying to develop competence at higher orders?
3. What time perspectives and ‘client readiness’ are needed for second-order or third-order change to occur?
4. Are systems with a wider variety of schemata more flexible and adaptive? Are these systems less efficient than others, as they lack single homogenous point of view?
5. Are systems capable of third-order change more ineffective in the short run as they compete with ‘true believers’ who are inextricably committed to a single schema they consider immutable reality?
6. Will they be more effective in the long run as external changes requiring cognitive shifts become increasingly evident?

A4.6 Knowledge Management – A Logical Behaviourist Perspective

Knowledge management has been of keen interest since the days of Taylorism, when industrial managers aimed to separate knowledge from workers as a scientific means of increasing industrial production and efficiency (Waring 1991). Before this time, knowledge had only been applied to improve tools, rather than general productivity (Schutt 2003). Knowledge management as it is currently conceived has its roots in the logical behaviourism9 espoused by Michael Polyani and Gilbert Ryle in the 1950s and 60s (Jashapara 2004). It is a young, multi-disciplinary field, concerned with the generation and sharing knowledge.

Snowden (2003) describes three ages of knowledge management. In the first pre-1995 phase, mainstream theory and practice adopted the Newtonian notion of knowledge as a ‘thing’, awaiting scientific discovery. During this time, knowledge management focused on IT applications for the structuring and flow of information to decision makers, i.e. information for decision support. The field was dominated by computer technologies, specifically in relation to cybernetic process re-engineering (Snowden 2003) and storing information on knowledge databases (Schutt 2003). As such, early knowledge management efforts were Tayloristic in their disregard for individual knowledge and capabilities (Schutt 2003) and the value of knowledge held and gained through experience (Snowden 2003). While valid in relation to manual tasks, this approach becomes problematic when dealing with ‘knowledge work’ (Drucker 1993), and the knowledge workers estimated to make up approximately 40% of the Fortune 500 workforce (Murray 1999, cited in Schutt 2003). According to Rasmus (2002, cited in Schutt 2003), approximately 80% of a company’s knowledge is personal knowledge of its employees.

Knowledge management scholars draw an important distinction between information and knowledge. Whereas information consists of interpreted data or factual statements (Drucker 2002; Kogut & Zander 1992), knowledge is more than just information—it is also that which gives people the capacity to act effectively (Dawson 2000). This distinction is related to notions of tacit and explicit knowledge, the most dominant concepts in the knowledge management literature (Jashapara 2004). These concepts have their roots in the early works of Gilbert Ryle and Michael Polanyi. Ryle, a behaviourist, made the distinction between ‘knowing how’, the intelligence associated being able to perform a task (e.g. a chef cooking a meal), and ‘knowing that’, holding bits of knowledge in the mind (e.g. memorising a recipe). He believed each involved two different mental processes (Ryle 1984). Polanyi, also a behaviourist, built on Ryle’s ideas to develop the notion of tacit knowledge.

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8 Logical behaviourism stemmed from Carnap’s proposed application of logical positivism to psychology, to limit psychological discourse to scientifically verifiable observations of behaviour, i.e. methodological behaviourism (Hauser 2005). Rather than deny the mental aspect of behaviour, Ryle and Polanyi opted for a metaphysical pluralism, whereby mind and body are seen as integrated on a tacit level (LeFave 2008; Polanyi 1969).
Polanyi’s premise was that we know more than we can say—for example we know how to ride a bicycle, but we cannot fully say how it is we do so. This ‘know how’, which we can’t articulate into ‘know that’, is tacit knowledge. Explicit knowledge is that which can potentially be codified and therefore articulated in speech or writing, but it only has meaning when embedded in tacit knowledge (Polanyi 1967).

Knowledge, therefore, can be viewed as having two dimensions: explicit and tacit. Explicit knowledge consists of information, i.e. data or interpreted data (Drucker 2002). However, a considerable component of knowledge goes beyond information to include ‘tacit knowledge’. Tacit knowledge is largely unspoken. It is described by Davenport & Prusak (1997) as “a mix of experiences, values, contextual information, and intuition that provides a framework with which to evaluate and incorporate new experiences and information,” (p.8). Because tacit knowledge is deeply rooted in an individual’s experience, it is difficult to share, requiring intimate human interaction, and time spent together building trust and understanding between individuals (Roux et al. 2006). When we express knowledge in facts and figures we lose the tacit dimension of that knowledge. And when we try to codify the associated tacit knowledge (i.e. write it down), we lose its context, because we always know more than we can verbalise, and verbalise more than we can write down (Snowden 2003).

Tacit knowledge is viewed as being much more powerful than explicit (Eraut 2000). Indeed it is through tacit knowledge that an individual or organisation derives its capacity to act (Nonaka & Takeuchi 1995). Jashapara (2004) notes that while explicit knowledge is easy to codify, store and retrieve using technology, being able to externalise the tacit knowledge embedded within the minds of individuals may very well constitute the ‘holy grail’ of competitive advantage. He suggests that insight and innovation are generated when tacit knowledge is tapped through dialogue and interaction between people, which often occurs around water coolers and in hallways. He further suggests that communities of practice (Brown & Duguid 1991; Lave & Wenger 2001) are a means of cultivating this tacit knowledge.

### A4.6.2 SECI model of knowledge conversion

In the 1990s Nonaka and Takeuchi (1995) developed their SECI model to demonstrate how knowledge is converted between tacit and explicit forms (Figure A4.4). Tacit knowledge is exchanged between people through a process of socialisation as people interact and share experiences. Explicit knowledge is exchanged via combination, as existing knowledge is reconfigured via a process of sorting, adding, relabelling and re-contextualising. Tacit knowledge is converted to explicit knowledge through a process of externalisation as the tacit knowledge is communicated via figurative language, images and metaphors. Conversely, explicit knowledge is converted to tacit knowledge through a process of ‘internalisation’ via learning (Nonaka & Takeuchi 1995).

Nonaka and Takeuchi’s SECI model largely kicked-off the popular knowledge management movement in the West, and it was widely used in many early attempts to “disembod[y] all knowledge from its possessors to make it an organizational asset” (Snowden 2003, p.23). In doing so, many knowledge management writers and practitioners treated the tacit and explicit as separate forms of knowledge, despite Polanyi himself having viewed the two as inseparable aspects of all knowledge (Tsoukas 1998). Schutt (2003) gives the example of early knowledge management projects that often consisted of senior management setting up empty databases, to which they asked staff members to contribute as a means of sharing their knowledge with the rest of the organisations. These databases, while perhaps garnering some initial attention, remained largely unused, even when incentive systems were put in place to encourage their use (Schutt 2003).

Snowden (2003) notes the irony in this, given that Nonaka and Takeuchi were attempting to use the SECI model to contrast the analytical Cartesian view of knowledge with a more holistic one based on the Japanese tradition of oneness. Their work had been based on innovations in Japanese manufacturing, where the tacit knowledge held by designers was being made explicit, but only to the extent necessary for a process to be undertaken (Snowden 2003).
A4.6.3 Ba & knowledge sharing cultures

The concept of Ba (Nonaka & Konno 1998) was introduced by Nonaka in an attempt to reframe the SECI model (Figure A4.4) and replace it with one which put greater emphasis on the dynamic and unbounded nature of knowledge (Schutt 2003). According to Nonaka and Konno (1998), Ba is a context that has meaning; it is a shared space (physical, mental or virtual) for emerging relationships, and a foundation for knowledge creation. Originating Ba belongs in the socialisation box (Figure A4.4); it is a space where individuals share feelings, emotions, experiences and mental models. Love, trust, caring and commitment assist in the exchange of tacit knowledge in this space. Interacting Ba belongs in the externalisation box; it is a space where tacit knowledge is converted to explicit knowledge as individuals share mental models and reflect on their thoughts and understandings. Cyber Ba belongs in the connecting box; it is a space where explicit knowledge is converted to more complex forms with the help of databases, groupware, etc. Exercising Ba belongs in the embodying box, and is a space where explicit knowledge is converted to tacit, via learning, mentoring and training.

Unlike the SECI model, Nonaka and Konno’s (1998) Ba model had little impact on the knowledge management field, largely due to its “strongly esoteric flavour” (Schutt 2003, p.453).

A4.6.4 Cynefin – Levels of Knowledge Abstraction

Snowden (2003) outlines the link between knowledge content and context in relation to exchange costs. When exchanging knowledge with a close colleague, the knowledge is easily transferred because there is a common context (e.g. background and technical jargon) so it can be done with a high degree of abstraction. However, when exchanging knowledge with an unknown person in a different field, a common context is lacking so the knowledge can only be exchanged with difficulty, using a low degree of abstraction. Snowden also identifies culture as being an important aspect of knowledge flow within an organisation. He combines the dimensions of abstraction and culture to create a sense-making model that he calls Cynefin, a Welsh term that conveys the link between communities and their shared histories. This model consists of four knowledge domains, illustrated in Figure A4.5 and described as follows:

1. **Bureaucratic/Structured: Teaching, Low Abstraction.** The formal organization, the realm of company policy, procedures and controls. It is a training environment, where the language is known, explicit and open (known).

2. **Professional/Logical: Teaching, High Abstraction.** Communities of practice, professional individuals, with specialized training and terminology, codified in textbook.
Appendix 4

The high level of abstraction can be taught with effort. Knowledge communication is at its most efficient due to the high level of abstraction (knowable).

3. Informal/Interdependent: Learning, High Abstraction. The shadow or informal organization, with shared experiences, values and beliefs. Complex network of obligations, experiences and mutual commitments essential to organisation’s survival. Knowledge conveyed through stories (complex).

4. Uncharted/Innovative: Learning, Low Abstraction. New situations, the ultimate learning environment, comprised of communities or individuals comfortable with extreme uncertainty. Members impose patterns on chaos to make it both comprehensible and manageable (chaotic). (Snowden 2003)

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Figure A.4.5. Snowden’s Cynefin sense-making (source: Snowden 2003).

A4.6.5 Knowledge as flow

Snowden (2003) characterises the post-1995 (second) knowledge management era has having a focus on management, and the movement knowledge between explicit and tacit states. Now however, he argues that we have gone beyond managing knowledge as a thing, to managing knowledge as a flow, with a focus on context and narrative, rather than content (i.e. knowledge management is becoming more constructivist). In doing so, Snowden believes we have entered a third knowledge management era. Walczyk (2008) notes that tacit knowledge, as expressed in concepts such as Ba (Nonaka & Konno 1998), has long underpinned knowledge management in the east. However, he argues that Western research is now adopting eastern tradition by shifting focus to the tacit dimensions of knowledge in organisational learning. According to Snowden (2003), this shift recognises human systems as complicated, complex, chaotic, and irreducible, with components that continuously change. He describes such complex systems as being characterised by “retrospective coherence in which the current state of affairs always makes logical sense, but only when we look backwards,” (p.13). Their current pattern may appear logical, but is only one of many, equally logical patterns that could have formed. Snowden suggests this is conceptualised by Stacey’s (2001) ideas of knowledge being rooted in complex adaptive systems (see Section A4.3.5):

Knowledge is not a “thing”, or a system, but an ephemeral, active process of relating. If one takes this view then no one, let alone a corporation, can own knowledge. Knowledge itself cannot be stored, nor can intellectual capital be measured, and certainly neither of them can be managed. (Stacey 2001)

In a similar vein, Schutt (2003) relates a 1998 conversation with Laurance Prusak whereby Prusak states: “You cannot manage knowledge like you cannot manage love, patriotism or your children.
A4.7 Communities of Practice – A Constructivist Perspective

In the 1990s, largely in reaction to the dominance of cognitive models in organisational learning, a number of scholars introduced socio-cultural perspectives on learning. These perspectives are based on idealist and constructivist notions whereby learning is seen to emerge from social interactions (Easterby-Smith et al. 2004). An example of a socio-cultural perspective on organisational learning is found in the community of practice school of thought.

The community of practice school of thought emphasises the importance of human contact in organisational learning, and the use of ethnographic research methods. Rather than being concerned with the cognitive processes and structures involved in organisational learning, it asks what kinds of social situations allow for learning to take place (Lave & Wenger 2001). In other words, this school of thought is interested in situated learning. According to Wenger (2004), communities of practice are “groups of people who share a passion for something that they know how to do and who interact regularly in order to learn how to do it better” (p.2). They are, voluntary, non-hierarchal, and largely based on informal networks, although they sometimes have support from formal organisations (Land & Water Australia 2006).

A4.7.1 Features

Wenger (2004) describes three features of communities of practice: 1) its domain, the area of knowledge being explored and developed; 2) its community, the people who interact and develop relationships in the process of sharing knowledge and addressing issues; and 3) its practice, the knowledge, methods, tools, stories and documents that members share and jointly develop. Generally a community of practice will consist of a small core group of actively participating members (10-15% of the community) who provide leadership and legitimacy, an active group who also participate actively but with less intensity (15-20%), and a peripheral group, who tend to observer rather than directly participate (65-75%). Members of this peripheral group perform an important role by using the knowledge they acquire to influence the activities of their home organisations (Wenger et al. 2002).

According to Wenger (1998), communities of practice are much more than a shared set of technological knowledge and skills—they are self-organising webs of relationships that emerge around things that matter as people share their knowledge. As trust and relationships form between members as they share knowledge and cooperate, communities of practice are able to take on larger, and more complex problems. This further enhances members’ sense of identity and purpose (Wenger 1998). Smith (2003) notes that the paramount role of relationships versus information (explicit knowledge) in the formation of communities of practice, is the belief that learning is in the relationships between people rather than just the simple transactional exchange of information. According to Smith:

Learning traditionally gets measured as on the assumption that it is a possession of individuals that can be found inside their heads… [Here] learning is in the relationships between people. Learning is in the conditions that bring people together and organize a point of contact that allows for particular pieces of information to take on a relevance; without the points of contact, without the system of relevancies, there is not learning, and there is little memory. Learning does not belong to individual persons, but to the various conversations of which they are a part. (Smith 2003)

A4.7.2 Informal Processes

Unlike formal organisations—where people operate under a mandate and focus on retaining control, avoiding mistakes and winning—those in a community of practice are not bound by a mandate or organisational membership, and use knowledge rather than rules as their currency.
(Roux et al. 2006). This reflects Gnyawali et al. (2005), who found that while knowledge accuracy can be improved by formal informational processes, improving the sharing of knowledge requires more informal, interactive processes. Likewise, Eraut (2000) found that most work place learning is informal, occurring in day-to-day interactions, through a process of socialization via “observation, induction and increasing participation rather than formal inquiry” (p.122).

A4.7.3 Job Descriptions and Training

Brown and Duguid (1991) looked at the effects of formal job descriptions and training on communities of practice. Applying Argyris and Schön’s (1996) earlier work on espoused versus actual theories of action, they argue that an organisation’s formal descriptions of the work it does (its espoused, or canonical, practice) differs from the actual work conducted by its members (its actual, or non-canonical work). Reliance on an organisation’s espoused practice blinds it to the actual, and usually valuable, work of its employees. Indeed, the authors suggest that conventional job descriptions mask the actual ways people work, and the learning and innovation generated by informal communities-of-practice (Brown & Duguid 1991).

Duguid and Brown (1991) also challenge the idea that training, and other practices which isolate knowledge from practice (e.g. office procedures), are effective vehicles for learning, stating that:

Training is thought of as the transmission of explicit, abstract knowledge from the head of someone who knows to the head of someone who does not in surroundings that specifically exclude the complexities of practice and the communities of practitioners. The setting for learning is simply assumed not to matter. (p.47)

In particular, they argue that learning is a social construction, and that knowledge must be put into context in order to have meaning. Duguid and Brown further argue that learners are ‘enculturated’ into a learning community’s particular perspective (e.g. that of plumbers, chemists, neighbourhood groups, etc.), learning its stories and to speak its language, so they fit in as members. Thus, learning is a process of “becoming a practitioner not learning about practice,” (p.48), with a focus on the communal context in which learning occurs (Brown & Duguid 1991).

A4.8 Summary

The social sciences present a large body of work concerned with learning, behaviour and knowledge (in both individuals and organisations), with potential application the environmental sciences. One of the early examples of such work is rational choice theory, which has long been used by economists and social scientists to model and predict people’s decision-making (Hausman 2008). Other early examples from organisational management include management-by-objective (i.e. Druckerism) and organisational development (Lewin 1946), which emerged in the in the 1940s and 1950s. Management-by-objective is concerned with improving the productivity of knowledge workers. It has its roots in Taylor’s early 20th century scientific management, as does industrial engineering, quality assurance, total quality management and cybernetics. Organisational development is premised on cybernetic principles, and uses participatory plan-act-reflect cycles as means of gradually improving organisational effectiveness. The systems dynamics field also arose out of cybernetics in the 1950s (e.g. Forrester 1968). Systems dynamics is used to understand the behaviour of complex, dynamic systems, including the behaviour of socio-environmental systems and organisations. More recently, organisational management scholars have been looking to complexity theory to help explain how human organizations learn and function, and to find ways of making these organizations more adaptive (Stacey 1996; Stacey et al. 2000).

Theories on organisational learning are largely drawn from theories of individual learning. Early learning theories were focused on behavioural modification (behavioural psychology). Later works by Gregory Bateson (2000) added a cybernetic perspective that viewed behaviour and learning as the consequence of interactions and feedback loops between the learner and his or her environment. In the 1960s, cognitive approaches to learning largely replaced behaviourist approaches. The central element of cognitive learning approaches is that they are premised on the
assumption of a fixed external reality, represented and stored in the brain as a mental map, or schemata, via cybernetic processes (Craik 1943). Learning occurs as feedback transforms these mental maps (or schemata), closing the gap between external reality and its representation in the mind. This is referred to as the information processing view of the brain and cognition. Research on cognitive dissonance has shown that presenting people with new information can actually cause them to entrench their existing behaviours and more strongly resist further change (Nyhan & Reifler 2010). Likewise, learning that does not result in major shifts in the governing beliefs and assumptions underpinning a learner’s mental models typically fails to change behaviour in substantial ways, and in fact often escalates errors being committed (Argyris & Schön 1996; Watzlawick et al. 2011). This is referred to as single-loop learning, the result of which is first order change. Double-loop learning and second order change only occur when learners question and change their values and assumptions.

In contrast, constructivist views on learning are based on postmodern notions of knowledge as something continuously created between learners through their social interactions and experiences (e.g. Shotter 1994). Watzlawick et al. (2011) bring a constructivist view to their principles of problem formulation and resolution, which involve reframing problems to achieve second order change.

Most organisational learning theories have their roots in cognitive psychology. These theories assume that organisations possess collective organisational mental models or ‘schemata’ from which their behaviours emerge, and that they are capable of single and double-loop learning (Argyris & Schön 1996). Model I organisations are those that focus on single-loop learning, and tend to fall into defensive routines and anti-learning patterns when confronted by change. Model II organisations are those which are capable of double-loop learning, and are characterised by openness, inclusiveness and willingness to surface conflict and reflect when confronted by change (Argyris & Schön 1996). Model I organisations are suited to exploiting old certainties in relatively stable business environments, whereas Model II organisations are more effective at exploring new possibilities in rapidly changing environments (Argyris & Schön 1996; March 1991).

Other key concepts in the organisational learning literature include organisational routines and learning organisations. Organisational routines are patterns of behaviour embedded in an organisation’s culture, beliefs, frameworks and day-to-day operations (Jashapara 2004). Once established, organisational routines can be difficult to change and may become counter-productive. In such cases, organisational unlearning may be required before new learning can take place; this is usually precipitated by a crisis (Nystrom & Starbuck 1984). Senge (1990) combines organisational learning with systems dynamics in his notion of the learning organisation. His work looks at the inter-relationships between an organisational system’s parts to better understand the whole, and is premised on the notion that organisations need to be continuously learning and adapting to survive in unpredictable environments.

While the organisational learning field is largely premised on cognitive learning theories, the knowledge management field, which took hold in the 1990s, has its roots in behaviourism. Knowledge management originated from behaviourist notions around tacit and explicit and knowledge, knowing ‘how’ versus knowing ‘what’. Whereas explicit information can be articulated in the form of speech, data and information, tacit knowledge is difficult to articulate and largely unspoken. It is a mix of context, intuition and experience that gives people the capacity to act (Nonaka & Takeuchi 1995). Many early knowledge management efforts were focused on finding ways of converting tacit knowledge into explicit knowledge. Other key concepts in the knowledge management literature are that of Ba (Nonaka & Konno 1998), and Cynefin (Snowden 2003), which treat knowledge as a flow rather than a thing. Complexity theory is now also being applied by knowledge management scholars as a means of better understanding how knowledge is generated, shared and applied in organisations. For example, Stacey (2001) sees knowledge as an active process of relating, rather than a ‘thing’ which can be stored and managed.

In the 1990s a number of socio-cultural approaches to learning, based on constructivist learning theories, also began to emerge. Among them was the concept of communities of practice (Lave & Wenger 2001; Wenger 1998), which emphasises human contact and relations during learning.
Appendix 4

Communities of practice are informal, self-organising webs of people who interact and develop relationships in the process of creating and sharing knowledge. The knowledge they generate is understood to be socially constructed and context dependent. Clearly the social sciences have much to contribute to our understanding of knowledge transfer in environmental management. The importance of using knowledge and feedback to improve adaptive capacity is not reserved for resource management agencies; to be competitive and successful, businesses must also be able to continuously learn and quickly transform their learning into action (Senge 1990; Senge et al. 1999)—i.e. they must be adaptive.
REFERENCES CITED


Appendix 4


Appendix 4


APPENDIX 5

ABBREVIATIONS AND ORGANISATION NAMES
## Appendix 5

Abbreviations and organisation names of nodes in the Ningaloo Network, with group designations interpreted from Figure 4.3 in Chapter 4 (Dzidic et al. 2011).

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Organisation</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIMS</td>
<td>Australian Institute of Marine Science</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>BAC</td>
<td>Baiyungu Aboriginal Corporation</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>BoM</td>
<td>Bureau of Meteorology</td>
<td>Peripheral-3</td>
</tr>
<tr>
<td>CCG</td>
<td>Cape Conservation Group</td>
<td>Governance &amp; service-1</td>
</tr>
<tr>
<td>CCPAC</td>
<td>Coral Coast Parks Advisory Committee</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>CFI</td>
<td>Commercial Fishing Industry</td>
<td>Isolate</td>
</tr>
<tr>
<td>Comm</td>
<td>Existing Community</td>
<td>Community</td>
</tr>
<tr>
<td>CP</td>
<td>Camping Accommodation Providers</td>
<td>Peripheral-2</td>
</tr>
<tr>
<td>CRCST</td>
<td>CRC for Sustainable Tourism</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific &amp; Industrial Research Organisation</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>Cu</td>
<td>Curtin University</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>DEC</td>
<td>Department of Environment &amp; Conservation</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>DEWHA</td>
<td>Department of Environment, Water, Heritage &amp; Arts</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>DoF</td>
<td>Department of Fisheries</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>DoIR</td>
<td>Department of Industry &amp; Resources</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>DoW</td>
<td>Department of Water</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>DPI</td>
<td>Department of Planning &amp; Infrastructure</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>ECU</td>
<td>Edith Cowan University</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>ESU</td>
<td>Eastern States Universities</td>
<td>Isolate</td>
</tr>
<tr>
<td>GDC</td>
<td>Gascoyne Development Commission</td>
<td>Governance &amp; service-1</td>
</tr>
<tr>
<td>GSA</td>
<td>Geosciences Australia</td>
<td>Peripheral-1</td>
</tr>
<tr>
<td>LI</td>
<td>Limestone Industry</td>
<td>Isolate</td>
</tr>
<tr>
<td>LRFG</td>
<td>Local Recreational Fishing Groups</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>LT</td>
<td>Local Tourism Operator</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>MU</td>
<td>Murdoch University</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>NCMC</td>
<td>Ningaloo Cluster Management Committee</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>NROCA</td>
<td>Ningaloo Reef Outback Coast Association</td>
<td>Isolate</td>
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<tr>
<td>NSDC</td>
<td>Ningaloo Sustainable Development Commission</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>NSDO</td>
<td>Ningaloo Sustainable Development Office</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>OGI</td>
<td>Oil &amp; Gas Industry</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>Pas</td>
<td>Pastoralists</td>
<td>Research &amp; advisory</td>
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<td>RFW</td>
<td>Reefishwest</td>
<td>Isolate</td>
</tr>
<tr>
<td>RHP</td>
<td>Resort &amp; Hotel Accommodation Providers</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>SI</td>
<td>Salt Industry</td>
<td>Peripheral-2</td>
</tr>
<tr>
<td>SoC</td>
<td>Shire of Carnarvon</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>SoE</td>
<td>Shire of Exmouth</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>TWA</td>
<td>Tourism WA</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>UWA</td>
<td>University of Western Australia</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>WAM</td>
<td>WA Museum</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>WAMSI</td>
<td>Western Australian Marine Science Institution</td>
<td>Research &amp; advisory</td>
</tr>
<tr>
<td>WC</td>
<td>Water Corporation</td>
<td>Governance &amp; service-2</td>
</tr>
<tr>
<td>WS</td>
<td>The Wilderness Society</td>
<td>Isolate</td>
</tr>
<tr>
<td>WWF</td>
<td>World Wildlife Fund</td>
<td>Peripheral-2</td>
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Research Uptake in Western Australia’s Ningaloo Region: Barriers & Opportunities

Stakeholder Interview Results

Compiled by Kelly Chapman
October 2010

IMPORTANT NOTE:
The comments in this document are the recorded opinions of those interviewed and do not necessarily represent fact or reflect the positions of any particular agencies, organisations or sectors.
Executive Summary

1 Introduction

The Ningaloo research program (NRP) has been underway since 2006, and is due for completion in 2011. It has brought together scientists from a range of disciplines and institutions. Its goal is improving our understanding of the Ningaloo reef and human activities along the coast, thereby allowing managers to make well informed decisions about the Ningaloo Marine Park and the region (findings to date can be accessed at www.ningaloo.org.au).

Fulfilling this goal will require research uptake. This depends on the ability and willingness of people, groups and institutions to learn from and use the NRP’s research to make more sustainable decisions (social, economic and ecological). There are, however, considerable barriers to research uptake, and studies show that there is a significant gap between research and implementation. As such, and despite best efforts, research, modelling and planning often fail to deliver expected on-the-ground changes.

I am an Edith Cowan University PhD student embarking on a project to explore this issue in the Ningaloo region. Between August 2009 and August 2010 I conducted over 30 interviews with researchers, government staff, business owners, tourism operators, pastoralists and community members, to explore their ideas around barriers and opportunities for translating NRP’s research into practice. This document contains the compiled results of those interviews (organised by theme).

PLEASE NOTE, the comments in this document are the recorded opinions of those interviewed and do not necessarily represent fact or reflect the positions of any particular agencies, organisations or sectors.

2 Summary of Interview Results

This data was compiled from interviews conducted with stakeholders between August 2009 and August 2010.

2.1 Barriers to Research Uptake

Cited barriers to research uptake can be divided into those internal to the research process and those external.

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1 The Ningaloo research program is a collaboration between CSIRO’s Wealth from Oceans Flagship, the Western Australian Marine Science Institution (WAMSI), the Australian Institute of Marine Science (AIMS), universities (Murdoch, Curtin, UWA, ECU, ANU and UQ), the Sustainable Tourism Cooperative Research Centre, and the WA Departments of Environment and Conservation and Fisheries, working with local communities and enterprises.
A number of uptake barriers *internal* to the research process were identified. These include: lack of local inclusion and feedback, lack of management impact, poor communication on the part of scientists, attitudes of some scientists, scale and uncertainty associated with the data, issues with the models, variable research quality, ethical issues around data sharing, and having too many scientists with overlapping topics.

**Lack of local inclusion and feedback**

Many local stakeholders were upset by what they felt was a lack of local inclusion and feedback in the research process. Some also felt that the Ningaloo Symposium wasn’t very effective at reaching local audiences. Other raised issues included: scientists having insufficient regard for local knowledge and concerns, difficulties accessing research, delays in research being released, bureaucracy impeding local participation in research, and difficulties maintaining long-term relationships between researchers and the region, particularly as researchers move on to new projects.

**Lack of management impact**

Many stakeholders felt that strategies for putting the research into practice were wanting. It was also noted that some researchers are unconcerned with the management implications of their work, and that research often lacks relevance to operational and pragmatic concerns.

**Problems with communication and attitudes**

Stakeholders noted that many scientists are not good communicators, and often feel that communication is not part of their role. It was noted that scientists have their own ‘language’, and sometimes have low regard for non-scientists. Idealism among scientists, especially younger ones, was also identified as a concern. Others noted occasions when scientists didn’t acknowledge the help or support of others, or broke rules and regulations in the marine park.

**Scale and uncertainty**

The scale of the research was raised as a barrier, particularly the lack of site specific information for planning and managing visitor activities and park infrastructure. The error and uncertainty associated with research being done in complex systems was also a concern.

**Issues with models**

Absence of a long term custodian for the models and lack of uptake by agencies were identified as major issues. Concerns were also raised about whether the models would be relevant to local issues and made available for local use. Some noted that the models might be too complex and that only very simple models would actually be used. In contrast, others were concerned the models won’t reflect real-world complexity and things like red tape and human feelings. It was also noted that some people would have unrealistic expectations of the models, expecting the models to predict the future and make decisions for them.

**Research quality, data sharing ethics and research overlap**

Other barriers to research uptake were cited as: variable research quality, ethical issues around sharing data, and having too many researchers in the region with too much overlap and too little integration between their topics.

A number of uptake barriers *external* to the research process were identified. These include: issues with government agencies, issues with the local community, absence of a regional vision, silos and lack of integration between groups, over-riding political concerns, and lack of urgency or imperative to use the research.
Issues with agencies

High staff turnover in regional government offices was a particular concern, as was agency staff lacking the time and resources to find and use relevant research. In particular it was noted that high staff turnover would confound attempts to provide agencies with model training. Loss of the NSDO was also cited as a major issue, as the NDSO was to be the major recipient of the research findings and modelling tools. Added to this is uncertainty over who will be responsible for managing the coastal strip. Poor agency reputation and anti-government sentiment in the region were cited as issues, as were modes of communication used by government, and the unwillingness of agencies to trust research carried out by the private sector.

Issues with community

A number of stakeholders noted that the Exmouth community is very apathetic, in part because it has a large transient population. It was also noted that many community members don’t believe in science and don’t like change that might be precipitated by research findings.

Absence of a regional vision

Not having a cohesive vision for how the region should be developed was cited as a concern. It was also noted that visioning exercises have no value unless they have concrete outcomes, and that previous visioning exercises undertaken in the region haven’t had follow-through.

Silos and lack of integration

Silos and lack of integration between groups and agencies working in the region were cited as major barriers. Some stakeholders were also concerned about the divide between researchers and managers, and between public and private interests.

Political issues & lack of imperative/urgency

A number of stakeholders felt that the research findings would be over-ridden by political concerns during decision-making. It was also suggested that research uptake by the region would be stymied by the absence of an ecological crisis and political, social and economic imperative.

2.2 Opportunities for Research Uptake

Opportunities cited for research uptake can be divided into opportunities where the research and modelling can be used, and opportunities for promoting uptake.

2.2.1 Using the research

Suggested uses for the research include: informing management of the area, assessing development impacts and trade-offs, informing policy and planning, education and awareness, market/tourism information, bringing stakeholders together, addressing cultural concerns, and supporting funding requests.

Informing management

A number of people suggested that the research and modelling could be used to help manage tourism and visitors, and to inform the decisions of politicians. Many also felt it could be used for managing the parks, determining park carrying capacity, and revising park management plans. Others suggested using the research for assessing the effectiveness of the sanctuary zones, planning for facilities and services, managing fisheries and the reef, and developing sustainability indicators.

It was also recommended that the research and modelling be used to help manage the coastal strip in relation to accommodating visitor preferences, assessing campsite locations, and planning for facilities and infrastructure. Using it to predict infrastructure and service demand in the towns and the region, particularly with respect to road works, waste and water, was also mentioned.
Assessing development impacts and trade-offs

Assessing the impacts of proposed developments, and negotiating trade-offs between interest groups were also cited as uses for the research and modelling. In particular, stakeholders noted the modelling could be used to assess new boat ramps, oil and gas projects, Straits Salt, and the marina expansion.

Informing policy and planning

Informing policy and planning was another widely cited use for the research and models. It was noted that the models could help with collaborative planning and consulting stakeholder groups. Some stakeholders advised that the models be used for the Ningaloo Coast Regional Strategy review and the Exmouth Structure Plan. Other suggested uses were: assisting the new Gascoyne Region Planning Committee, supporting National Landscape branding for Ningaloo, conducting regional planning and visioning exercises, and assessing the impacts of World Heritage.

Education and awareness

Stakeholders also recognised how research could be used to educate the public and foster responsible behaviour. Some suggested the research could be used by tourism operators to inform their clients. It was also recommended that the models be used as learning tools, to people gain a better understanding of how complex systems such as Ningaloo work.

Market/tourism information

A number of people felt the research, especially the tourism destination model and the visitor statistics, would provide useful information about tourism and the market.

Bringing stakeholders together

It was also suggested that the research be used to bring together different stakeholders in the region, to share information and issues, build understanding and get people working together.

Addressing cultural concerns

There was hope that the research would address cultural concerns along the coast, particularly in relation to its cultural significance to Aboriginal people and ensuring people respect and take care of the coastline.

Supporting funding

Others saw that the research and models could be used to support funding for things like future research and local government services.

2.2.2 Promoting research uptake

Suggestions for promoting research uptake in the region included: promoting ongoing use of the research and models, engaging stakeholders and communicating the research results.

Promoting ongoing use of research

The importance of sustaining ongoing relationships between researchers and the region was stressed, as was having a “leave something behind strategy” to build capacity and leave a permanent presence. Others cited the importance of WAMSI’s knowledge transfer framework. Engaging a coordinator to help get the research results to the community was also suggested. Some felt that creating a new regional body, like a Ningaloo Trust, would help research uptake, whereas others felt that improving existing government structures would be a better option. Other suggestions included: partnering with landholders and tourism operators to get the research results out to the public, hosting a forum to discuss potential management applications of the research, posting follow-up research opportunities on a website, and integrating data with that of other agencies.
Promoting ongoing use of models

Making the models accessible to everyone was cited as important, as was simplifying the models and developing visualisations of the model results. Several stakeholders stated that the models should be housed in the region; suggested homes included the GDC, the Gascoyne Regional Planning Committee, the Shires and the proposed Ningaloo Research Centre. Hiring a regional person to support and promote the models was also recommended, as was collecting questions from stakeholders, running requested scenarios, training people and agencies to use the models, conducting model demos around the region, evaluating and updating the models over time, and building trust and interest in the model outputs. It was also suggested that the models address red-tape and triple-bottom line concerns.

Engaging stakeholders

Identifying key stakeholders in Perth and the region, and devising a plan for engagement were recommended. Suggested target groups included: politicians and cabinet, government agencies and regulators, indigenous groups, local residents, pastoralists, tourism operators, businesses, recreational and commercial fishers, accommodation providers, schools, industry, consultants, and the scientific community. Engagement with the Cape Conservation Group, Exmouth Game Fishing Club, Chamber of Commerce, Ningaloo Research Centre working group, Coral Coast Parks Advisory Committee, Cape Board Riders, visitor centre committees, Coral Bay Progress Association, and the Ningaloo Turtle Program, was also suggested.

Communicating research results

Numerous stakeholders emphasised the importance of getting the research results out and making them available to everyone. Some suggested developing a communications plan and partnering with other agencies such as DEC and the GDC to roll it out. The importance of communicating rather than just putting out information was also stressed. Other suggestions included training scientists to become better communicators and using mediators to help scientists communicate. The importance of having a ‘no surprises’ policy for government and locals was also underlined.

Stakeholders also made recommendations on how to format the research results. These included: using formats that meet stakeholder needs, using simple language, organising results by theme or subject, and focusing on recommendations (rather than methodologies). It was also suggested that the research be assembled to tell a story, and that research interpretation focus on ‘what’s in it for them’, highlighting the benefits for business, government, lifestyle, etc.

Numerous communication channels were also recommended by stakeholders. The importance of face-to-face contact was stressed, via presentations, forums and one-on-one meetings, particularly for Aboriginal groups. Other suggested channels included: research summaries and fact sheets, research reports, government briefings, a website, links to high traffic websites, coffee table books, displays, magazine articles, media releases, flyers and mail outs, contact database, newsletters (hard copy and electronic), maps, Google Earth, schools, libraries and community centres. The proposed Ningaloo Research Centre was also repeatedly identified as a venue for showcasing the research.

2.3 Designing research for better uptake

Recommendations for designing research for better uptake included: planning for management impact and communication in the research design phase, promoting interdisciplinary collaboration and community engagement, assembling an innovative management committee, changing research culture to focus on real-life impact, including knowledge transfer and communication in research performance standards, and building information sharing into the research licensing process.

Planning research

Suggestions for the research planning and design stage included: making communication proposals a required component of grant applications, spending more time scoping research projects, using an
interdisciplinary approach to project design, taking care to relate research to management, and planning for a post-research presence in the study area.

Promoting collaboration and community engagement

Interdisciplinary collaboration and community engagement were identified as key ingredients for research uptake. Specific suggestions included: employing a coordinator to facilitate the research-management interface, engaging locals in the research process, involving stakeholders in model development, and being prepared to address conflict.

Managing innovatively and effectively

Having an innovative management committee that’s made up of diverse, accomplished individuals was identified as an important success factor.

Changing research culture

Some stakeholders recommended changing research culture so it’s more focused on having real-life impact, via greater collaboration, risk taking and experimentation.

Evaluating research

Including communication and knowledge transfer in research performance standards was also recommended.

Licensing research

In addition, it was suggested that researchers be required to consult local agencies when preparing licence applications, and to report their research findings to these agencies as a licence condition. Better sharing of information on research licenses was also recommended.

2.4 Regional Context

Stakeholders also made numerous comments about other issues and initiatives in the region, unrelated to research uptake. These pertain to: the Ningaloo Research Centre, pastoral stations, government, the shires, park management, the Ningaloo Coast Regional Strategy, recreational fishing, boat ramps, industrial development, marina expansion, groundwater, World Heritage, National Landscapes, local attitudes, renewable energy and the Ningaloo Turtle Program.
First and foremost, many thanks to the people who took time out of their busy schedules to meet with me and provide their valuable input for this document. Thanks also to CSIRO and ECU for funding this project, and to the Ningaloo Turtle Program and DEC Exmouth for providing me with office space. And finally, special thanks to all those who offered me places to stay, those who hosted me in their homes, on their properties, on their boats, and in their meetings, and those who gave me encouragement, moral support and friendship along the way.
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Introduction

The Ningaloo research program (NRP) has been underway since 2006, and is due for completion in 2011. It has brought together scientists from a range of disciplines and institutions\textsuperscript{2}. Its goal is improving our understanding of the Ningaloo reef and human activities along the coast, thereby allowing managers to make well informed decisions about the Ningaloo Marine Park and the region (findings to date can be accessed at www.ningaloo.org.au).

Fulfilling this goal will require research uptake. This depends on the ability and willingness of people, groups and institutions to learn from and use the NRP’s research to make more sustainable decisions (social, economic and ecological). There are, however, considerable barriers to research uptake, and studies show that there is a significant gap between research and implementation. As such, and despite best efforts, research, modelling and planning often fail to deliver expected on-the-ground changes.

I am an Edith Cowan University PhD student embarking on a project to explore this issue in the Ningaloo region. Between August 2009 and August 2010 I conducted over 30 interviews with researchers, government staff, business owners, tourism operators, pastoralists and community members, to explore their ideas around barriers and opportunities for translating NRP’s research into practice. This document contains the compiled results of those interviews (organised by theme).

PLEASE NOTE, the comments in this document are the recorded opinions of those interviewed and do not necessarily represent fact or reflect the positions of any particular agencies, organisations or sectors

\textsuperscript{2} The Ningaloo research program is a collaboration between CSIRO's Wealth from Oceans Flagship, the Western Australian Marine Science Institution (WAMSI), the Australian Institute of Marine Science (AIMS), universities (Murdoch, Curtin, UWA, ECU, ANU and UQ), the Sustainable Tourism Cooperative Research Centre, and the WA Departments of Environment and Conservation and Fisheries, working with local communities and enterprises.
Barriers to research uptake

1 Internal Barriers

1.1 Lack of local inclusion & feedback

1.1.1 Lack of feedback to local people and agencies

- I’d say that most operators don’t even know what research is going on. I know some things that are going on, like the tagging research, the research on rays… putting these little sonic tags onto rays and yeah, we helped her out a bit. But yeah, we don’t get any of the information back, nothing.

- Which then gives us a bit of a bad taste because the next researcher comes along and says, ‘Oh, can we do this?’ And we’re like, ‘no, not really because the last researchers didn’t give us any information.’ The person that’s been very good has been [name] from the Hutts Research Institute in San Diego. We do satellite tagging on Whale Sharks with him. We get that information updated weekly, where the whale sharks are. And he comes out on the boat once for a week every year. AIMS we see a lot of. But they just come up and get their air fills from us.

- But getting your hands on research seems to be quite difficult, researchers don’t tend to give it out. When you contact them some don’t respond and I’ve contacted a few over the years. Probably about half don’t respond, if not more. I guess they’re so focused on what they’re doing. Obviously the researchers have got a deadline, and it’s a lot to get done in a 4 year timeframe.

- Generally the perception about research is that it’s fly-in/fly-out and really locals don’t really know a lot of what’s going on. Maybe that’s unfair but…and the researchers do work at it, they do come and meet with people like me and perhaps with the Shire, but there’s still that element of unfamiliarity with the uni world, you know? It’s harder for me to comment about say fisheries research and linking it into how the Department of Fisheries have taken it up in policy. I presume it might be going on quite successfully, but I don’t know.

- I haven’t seen any results of the research at all. A couple of things from [name] has come through saying that he’s got some stuff coming up. He’s been through twice, I think, that I’ve spoke to him.

- Community members are definitely interested in the research and getting access to it, but a lot of people don’t know what research has been done in the area.

- But there’s this whole vacuum where we haven’t been able to get the research findings down to grassroots level.

- I’m aware that research was going on and no more, probably don’t more anymore details than when I first found about it when I attended a Sea Change Taskforce Meeting in Port Douglas about 4/5 years ago. It was announced there that this was going to be happening and a fantastic thing that was going to happen on the Ningaloo coast. It was the first I heard of it, and really I, I haven’t heard much more

- I’ve known that’s there’s researchers going around doing lots of survey work but I haven’t really had any contact. The same chap who was at Port Douglas, he may have been in town a couple of years ago and
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gave a brief to council, but I couldn’t be 100% sure on that. I think I was either away or on leave. I just got this something that tells me that there was some sort of a presentation to council about what was going on, but I don’t recall much about that.

- There’s not a Ningaloo specific research website, is there? [there is, yeah]. And I’m someone who is aware of stuff. I’m sure it probably came out somewhere in the Symposium but once again got buried underneath.

- You just need to be able to access the research, and I think that’s what the community’s complaining about. All this research has been done and right now no one can access much. And no one’s telling us what’s going on.

- It is a tragedy that the scientists in Perth fully understand this [how the reef functions and pressure from issues such as recreational fishing], that Government agencies have an appreciation of it, but you don’t see the research findings being fed out to the people on the ground, who then is not in a position to help you even though they would have had they been informed of the results. The landholders, managers and tourism operators are the hands feet and eyes on the ground. Every day, all day. If they know what’s going on they can divulge it down to visitors and the public, over which they have a lot more influence and contact than any of the Government agencies as they’re seen as a lot closer. An ‘us and them’ mentality between researchers, universities, Government and land managers is not helpful to this process.

- There is very little to no dissemination of information on what the scientists are doing in the area. We often don’t even know that the scientists are coming. The visitor studies have been going on for three years. Are they purely for government use or are they for people living on the reef as well? Should that information not be coming to us as soon as it’s available? We need the information. You get snippets, but only here and there through personal relationships. Apparently they have to collate all the results and put it all together, but surely they’ve got an idea and a guide.

- It only takes a bit of cooperation. They come and do research, there’s no reason given why they’re doing it or what they’re going to do with the information once gathered. We participate with the researchers, but ask for copies of the research/papers once completed. But it’s mostly not forthcoming. Some of the smaller Honours papers come back, but very little comes back from the bigger stuff.

- From my point of view, I think it’s really worthwhile what you’re doing because one of the things that concerns me is that I’m well aware that a lot of money has been spent through WAMSI, and yet, because of my area of interest and also because I teach at the school, I don’t feel that the community in general knows what’s going on or if they do know a little bit about what’s going on, that we actually get any feedback.

- I’m aware of [ ]’s work because [ ] actually has given a couple of community talks, explaining what he’s going to do and I think that’s very, very helpful. Otherwise the community feels the researchers come in and come out. I wouldn’t have a clue who’s doing any research up here at the moment, other than yourself.

- Over the years there’s been that many different research projects going on. And to be quite honest the feedback of the information has been really limited. [ ] obviously gives a bit with his id stuff and that, [ ] is probably the only one that comes back with some flow back to the community and actually makes time to come back up and try and have meetings with the community about where they’re at with things and what their findings are. And I suppose their research is more people-oriented.

- As far as someone doing a survey on a sea cucumber or water quality or nutrients, there hasn’t really been much of that feedback back to the community. Lots of people come in with big government grants, they just come in and come out, and that’s it. [ ] in Coral Bay, he does manta-ray research and he’s based in Coral Bay all year, so he actually has more information flow with the operators doing the manta-ray tours down there. The same goes for [ ], who heads up the Murdoch research station at Coral Bay.
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- I can understand the frustration in the region [regarding research]. For example, I went to see a pastoralist yesterday to ask if I could do some research on his station, and was told they’re both sick of researchers coming through and seeing nothing in return, so I can sympathise with that point of view.

- I’ve only been here a few months so what I can comment on is limited to that timeframe, but the thing that becomes apparent to me from talking to other staff here is that somewhere along the line there is a block in feedback. Yes, we know that researchers are coming in, we get the permits, they say yeah, this is what we’re doing, and then we never hear anything else.

- The Ningaloo Research Symposium was really good because it was ‘oh my goodness, all this information is coming out’ which will be really useful for us for management options, in terms of, ok we know this is the trend of what’s happening here or whatever. But we’re just not getting the research.

- I’m not exactly sure where the block is happening. Whether all the research is actually coming back to Marine Science and they’re just pooling it there and thinking that people know about it, or what the situation is. Because there’s certainly a lot of that stuff that people were reporting on at the Symposium that we take and say: ‘We know from what the researchers have been doing that fish stocks seem to be down here but they’re up here or the puerulus settlement stuff or whatever.’ It’s great to see that there is some information out there that says, ‘sanctuary zones are working and blah-blah-blah,’ but that feedback needs to come back us.

- There is a feedback process but it’s just not going far enough and that’s something that I have thought I really need to look into, as to: what’s happening here, where is the feedback going, and how is the information being disseminated?

1.1.2 Lack of local inclusion/consultation

- That is our biggest issue with all of this stuff and that’s why we get fatigued and disillusioned with process. We’re fatigued with research and consultation because it most often excludes our views from the real decision-making processes. So all the time and money we put into it, nothing comes from it. It’s just so they can tick the box ‘yes, they were consulted. They were told how it is’.

- There’s very little real inclusion of locals in the research by many of the researchers that have come through. It’s a scientist-layperson divide that seems to exist. But the scientists are here one day in a month and the ones that live here are here 24/7. The research seems to be on an on-the-spot basis, once every month, once every three months. It is not a complete picture of what happens.

- was inclusive, but what I would say it was mainly to do with the connection – they had something in common to begin with. Their guys were good, they called in every time they went through. But we didn’t see any of the results.

- I don’t believe whatsoever in consultation. Consultation doesn’t exist. It’s just a box to tick. It means nothing. That’s researchers, Government agencies, NSDO, across the board. Consultation is a myth. Definitely in Western Australia.

- We have scientists from overseas coming into town who you never know are here. It’s just sheer coincidence that someone goes to me, ‘Oh , do you want to go down and do some mangrove work with so-and-so?’ And it would be nice to know all of this stuff. Because it’s a lot of money to spend if research isn’t actually being used.

- That’s the other thing that concerns me, occasionally you hear about people getting involved but I go well, how did they know about that, because generally I’m in the know and I would like to get involved, and I would like to know if there’s an opportunity for any of my students to be involved. I think that’s also very important. And as the science teacher at the school I would like access to some of these scientists, and for them to make themselves available to come and talk to the kids at the school. I think that’s important as well.

- You have to apply for a research licence down south. I know the district DEC manager used to scratch his head sometimes and think, well, ‘don’t you think it’d just be courteous for the researchers to call into DEC’
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but I know sometimes people don’t. Some of them do but not all of them do. The researchers are so focused on what they’re doing because they live in their own little world and they don’t stop to think about other things. And it’s not a criticism of them but...for some of the young ones, their egos drive them.

- Now that all the projects are finishing, they’d be looking at whether or not it was the correct way to spend research funds. If there’s anything to come out of down the track, it’s more community consultation as to what some of the locals think other projects could be, and less repetition of the same research.

- Community consultation probably needs to be a bit stronger than what it’s been - a two-way flow of information.

- Lack of indigenous engagement has been a serious concern for me. At this late point, it’s not realistic to expect genuine engagement with indigenous people. The different cultural values and requirements for indigenous people have been absent in the modelling exercises and in research protocol. Although I don’t think non-indigenous people were widely engaged either.

- The research questions seem to be answering white people requirements or questions as opposed to indigenous people’s requirements. It’s a process concern.

- Research uptake is a harder sell if the research questions aren’t developed with the managers, even if the questions answered are potentially useful to managers.

1.1.3 Bureaucracy impedes local participation

- Maybe you require a DEC person to be involved in the research, but once you have these rules, it can impede research. [what about informally inviting local people on research trips?] But for us we can’t have anyone on our boat legally, they have to sign off all this paperwork, this makes it very difficult.

1.1.4 Insufficient regard for local knowledge/Issues

- The research seems to be drawn up and carried out by people who don’t live in the area, who don’t have any real links to the area. Fly-in, fly out, do their bit and go. There doesn’t seem to be any real inclusion of locals. They don’t include the knowledge base we have living here day to day. There’s no real regard to what the day-to-day means for managing the area in future. It’s continuous, its not just the research - World Heritage, National Heritage, the coastal exclusion process, it all seems to be done by people who are not from the area.

- At the Ningaloo Symposium there were a lot of scientific papers presented with no regard for day-to-day management of things.

- I suppose I’ll have a bias against the models straight away because how do they know? It’s all high level theory stuff but will they show the illegal camping sites that the guys are going to go to once we turn them away from ___ because we’re full? I can tell you the eleven sites that they’ll be at. That’s the stuff that you won’t know unless you’re policing it all the time. Because the other sites are inaccessible or they’re not really nice for camping. But these certain places, that’s where people want to be. Stuff like that I wasn’t asked about.

- But its probably always been that way and always will be...people who put their life into doing environmental science think, how can the guys who look after ___ know as much as they do, which, in a lot of ways they’re a hundred percent right. But there are things that ___ will know that they will never know. If they were good scientists, they would talk to and include local people. We might not have scientific knowledge, some of what we say might be a load of bollocks, but we know what we see and some of that has got to be relevant. A good researcher should be able to pull that out. It also lets scientists down because they are not getting all the data they could get, that extra bit of local knowledge. Obviously they’re getting good data and they’ve got good ideas and the ability to present, but it’s got to be lacking that bit of local knowledge.
1.1.5 Ningaloo Symposium – didn’t reach locals

- I came up for the last session of the Ningaloo Symposium, but a view I think you’d find with a lot of locals that they don’t really know too much of what’s going on. And without being critical of anyone in particular, the symposiums do mainly have a look of researchers telling other researchers what they’re doing. When you looked around the room [at the symposium], there weren’t many locals. There were some government people, like me and Tourism WA. So I think that’s why what you’re doing could potentially be very valuable from a regional point of view. Yes, definitely.

- The symposium was open to anyone in the region, but science was the main audience. There was some representation from the stations. We missed some of the tourism operators in Coral Bay and we had feedback from them that this should have been done better. [Name redacted] were the main operators who attended; We had discussions with a representative from Tourism Australia at our meeting with the Ningaloo Sustainable Development Committee.

- The thing with the Ningaloo Symposium is some of the speakers presented information that was really interesting and some of the speakers, well, I don’t really understand what their topic even was.

- The symposium was fine, but nobody has two days to sit there and listen to everything, and it didn’t reach local audiences. It was targeted at scientific audiences – it helped coordination between the projects.

- I was disappointed and concerned that there weren’t more land holders, managers and tourism operators along the Ningaloo Coast present. Another attendee made the same remark – she said she was frustrated there weren’t more tourist operators there.

- It took me 2 years to be invited to the Research Symposium. I didn’t even know it was on. And then, on the Symposium day in Exmouth during May 2009, I was one of only three representatives of landholders / tourism operators on the Ningaloo coast. When we raise these issues or make these points at the Symposium, there does not seem to be any recognition of any need whatsoever for greater involvement of the landholders / tourism operators, who are seen as part of the problem and not the solution. That is a key issue for me. We are part of the solution. We are not the problem.

- I think the Ningaloo Symposium shows that they’re not doing a good job at getting it out there.

- At the symposium on Wednesday night they had community workshop. What happened is ‘we’re telling you what’s going on’. It was promoted as a community workshop and people nowadays know that a workshop is where you get asked your opinion and a facilitator takes notes. This was a ‘what’s going on’. It was a presentation, really, so the people from the community have gone, ‘Oh, don’t bother going, that’s a waste of time.’ So you influence communities based on how you start off. If you say to them ‘we’re gonna have a workshop’ you’ve got to have a proper workshop. If you’re going to do a presentation just tell them ‘I’m doing a presentation’. So you get to hear the other side that way.

- When they have a Ningaloo Symposium up here, it’s quite well advertised and you can go. I couldn’t go, so I spoke to a friend of mine from CCG who went, and she said, ‘Oh, you didn’t miss anything,’ she said. ‘By the time we got to the community workshop, all the scientists were obviously over it, they were all pissed and they really didn’t care.’ I mean, I know scientists are human beings and are allowed to let their hair down. But if you’re doing a general workshop for the general public, I don’t think that’s a good...it would be like me turning up to a parent night pissed, you know.

- The Symposium they had earlier in the year was quite successful but very low local participation. A lot of those people needed to be spoken to from a local perspective on it, but most of the scientists flew in, went to the hotel and went to the Symposium and flew out again. They might have done one quick lap around the other side and that was it, they left without really getting the feel of how the ecosystem works together in the region.

- I saw that symposium as such a big shame. That all those people came into this area and nobody on the ground really got to know them or even an opportunity to talk with them. There was no public forum, even just two hours where tour operators, off-shore workers and business operators in the region could have come in and learned. Even the taxi driver said I would’ve come if I had of known that was on.
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information has got to get fed out there otherwise 3 years worth of funding is really just going to nowhere and get locked up in nice little documents that sit on the shelves at DEC and in universities, and then what happens next?

1.1.6 Inaccessibility of Research

- I think that's one of the biggest things, you don't know who's doing what research, you have no idea, and then how you get hold of that information — and if it is published, how do you know where it’s published? But it’s good that WAMSI gave us a list of everybody and their email address and what their topic is, and a spiel about it. So I’ve used that to contact people directly. And they’ve sent another one out before that, it’s been updated a couple of times. But that doesn’t even include all the oil and gas research that goes on that you can’t get access to that would be useful — or not just oil and gas but other industries. The private sector stuff. I’ve just been to Pannawonica and met someone who works for Rio Tinto out there, they own the town, and apparently they’ve found a little stygofauna out there that they thought was only confined to this Cape. But there’s no way of knowing that information because it’s a private company. They sent it to the Museum or something but, do you know what I mean, how would we find out that information?

- [how important is it (if at all) to have some contact with the researchers themselves?] We never know which bit of information we need. I’ve asked a couple of questions about climate change and all the CO₂ emissions here... not that they could really answer them but it was nice to be able to ask someone with a bit of authority and knowledge about what the impact potentially could be. But we wouldn’t really access them directly. It’s more their results that we’re interested in.

- [Researchers think the managers just need to go to the literature and read all the papers]. Ok, but in the real world, whose got time to do that? Or access to it? And how do community people and volunteers get access to all that? It’s not like we can go down to the libraries and unis in Perth and flick through stuff. I guess there’s material available online and on the web but often you’ve got to pay for it and that’s a problem for a non-profit group as well.

1.1.7 Delays in research being released

- [Often the delays are caused because there are intellectual property issues until the research is published] Who is paying for the intellectual property? The tax payer. That research has been on for 3 years. What use has that been while I’m developing here? When I now find out that only 5% of visitors use the Ningaloo Reef for surfing, why would I put a surfing camp here? We have no information whatsoever on current users or how future uses might change.

- [Tod Jones has been comfortable giving me specific information even though his total project isn’t complete. Contrast this with other researchers whose data - which would have been very useful – we couldn’t use because wasn’t published. My plan will already be finished by the time the data is available.]

- I asked for copies of what was presented at the Ningaloo Symposium, because there’s a lot to take in and try and write down. You’ve got the information there now. Surely if you’re really, truly passionate, you would want to get it out there for people so the educational process can start. But obviously I don’t understand the politics of how it works, that whole process. The researchers aren’t just doing it for the good of the ocean. It’s their livelihood, it’s their jobs, their careers and there’s a process in there which obviously I don’t get. I’ll have to get an understanding of how it all works, because then maybe my expectation will be different...How long does it take someone to do a paper once they’ve finished the research? [It can take years – submission process explained]. And by that time the sea cucumbers become extinct.

- It’s fantastic that all this research is happening but really we’re waiting 3 to 5 years or more to actually see a published paper or get a bit of feedback from what’s happening. It’s not really the most helpful. Even just after researchers have been up here it would be really good to have a brief summary of ‘OK, this is what we’ve found, this is what’s happening.’ Just so that we’re aware.

- We’ve been very lucky so far in that we haven’t had anything major crop up. But if we’re trying to deal with something and someone says, ‘oh yeah, I actually found that out 3 years ago when I was looking at this,
that or the other. ’Well, that would have actually been really good to know. So that would be my main comment.

### 1.1.8 Researchers moving on

- Someone at the last NSDO meeting said: “you guys are nice, but you’re all tourists, science tourists. You’re here now, but once the project is finished you’ll go somewhere else, which is what scientists do. But you’ve invested 30 million dollars in this place, and if there is nobody here, there’s no face to it and it’s not going to be used.” And he’s dead right.

- The researchers want to wrap this up. I reckon we’ve got about 12 months. Even though officially the WAMSI work finishes end of 2011, by the end of next year the attention of most researchers will have moved on, and they’ll only be attending to contractual obligations, final reports, etc.

- When this whole thing wraps up CSIRO will necessarily move on. CSIRO’s mandate is to deliver research; it’s the role of the agencies to see the research applied.

- CSIRO will try to bed their research down with recipients and stakeholders, but then they are compelled to move on to new projects. We usually can not become attached to the place – we physically can’t because we’re on new projects that we have to be dedicated to – that’s just the structure of research. In a way, there is a high need for research across Australia, and so we can’t just be fixated on one problem. Thus, it when we finish a project it should be written up and delivered in a complete package.

- One of the messages I got was: we’ve done all this work, we’re not going to be in this area doing this research forever, we’re going off to do more research in New Zealand or the Kimberley or somewhere. So who’s going to look after the research? If this is worth doing, it’s not point-in-time research because you have to keep it up to date, to keep it alive. So who’s going to keep it alive? When you get right down to it, the people who are really committed to the place are the people who live here and so they should be the ones. But if they don’t know enough about it or understand it, they’re not going to do anything. In some ways, it’s organisations like us that are quite limited in resources anyway…and no one’s saying: can you keep our model alive. It’s all still a bit of a vacuum there, you know?

- The bald reality is scientists are honestly thinking (but not necessarily saying): I need to finish my project by August, and when I finish my project I’m out of here.

- What happens to when he’s finished – does he keep promoting it, or after 12 months of trying to push it does he figure job’s done and he walks away? Or goes off on a different tangent and drops the ball because there’s no money after this lot.

- People are already talking about moving on to the Pilbara. I’m part of that; I’ll have to move on, because I won’t be allocated any time to work on Ningaloo. The reality is we have to follow the money – we don’t decide on that.

- [I can see potentially lots of different applications for what you’re doing and it could inform planning processes] Which is good, I’m just not sure whose responsibility that is. You do hope it has some application. If you read my candidacy, of course it says this could have useful implications in the region and la-la-la-la, but as a junior researcher again you have limited time and a limited budget and by the time you submit your thesis for marking…in many ways don’t feel confident about my work until it’s been marked. I might submit my thesis for marking and then it takes a couple of months to have it marked, and by then I might be kind of working elsewhere or on an entirely different project and might be geographically removed and might be emotionally removed from the whole process.

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### 1.1.9 Difficulty maintaining relationships/engagement

- The relatively limited life cycle of a research project doesn’t always allow for prolonged relationships, although much of the work we do ends up being with the same network of colleagues, so relationships do
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live on in this way. The biggest challenge is that I'm not a WA resident, so I can't be canvassing the 
corridors of other institutions in other states saying “are you sure you understood that.” I suppose this 
requires us as researchers to identify the key contacts and make sure that there are good lines of 
communication.

- This project’s been difficult for me to engage with because it’s spread out over an entire continent. It’s 
been really hard for me to figure out who the right people are to contact, who the right players are, etc. 
But that’s the nature of working for a national agency working on regional problem – it’s both a challenge 
and an incredible opportunity.

- Participation was probably highest in the first round of forums, where we did personal invitations (~150 
phone calls) and promotions in local papers. Since then participation has dropped off because I’ve mostly 
been sending out email invitations and only calling a few key people. Personal invitation is the most 
effective way of getting people to show up.

- It’s more difficult to engage people on tourism related issues, than fisheries for example. In fisheries there 
are well established user groups, whereas tourism is disperse, it influences everybody and nobody, so 
actually trying to find a way of talking to everybody is very difficult.

- Sometimes I’ll get calls from agencies on past work and I’m more than happy to answer a few questions – 
but those questions don’t come that often. I haven’t been here that long so I don’t have that long of a 
history I only have a track record from a few projects involving external agencies, which I do get some 
questions from. I think that will grow with time.

- CSIRO doesn’t encourage long term relationships in an area, and I think that’s actually part of their remit, 
they’re supposed to hand-off after a research project is finished. So you have to make sure you actually 
educate people on the ground before you leave, which is one of our reasons for engaging so heavily with 
Curtin, to have a longer term presence over there.

- In Ningaloo there’s the potential for a longer term research relationships if we pull things off as well as 
Keith Sainsbury’s work on the NW Shelf. But if it gets seen as an expensive exercise that gets put on the 
shelf, there’s not much hope.

- We need to iteratively go back to the guys up in Ningaloo and show them how things are going and the 
questions involved. It’s a two edged sword because they’re busy and don’t want to be continuously 
interrupted by visiting scientists. But you can’t fall off the radar then magically appear at the end – they 
won’t be engaged. It’s treading that fine line, getting up there often enough to be considered a friend, 
versus being there too often and considered a nuisance, or so little you’re a stranger.

- As with everything, the success of adaptive management and ecosystem modelling comes down to the 
individual personalities involved. People have to be willing to put in the time to be seen, talk, be friendly, 
buy a bottle wine, etc.

- Quite a few scientists aren’t interested in meeting face to face with users and establishing relationships, 
but others are. Initially, the CSIRO project was supposed to be all about science excellence; it wasn’t 
supposed to have any end user engagement. Fortunately that changed, about 18 months into the project, 
but the project had been scoped and budgets allocated by then.

- Talking directly to local people and decision-makers is not a priority for scientists – they see doing their 
research as their number one priority, but saying that, when we ask for a grant its one of the things we say 
we will do (communicating our findings).

1.2 Lack of management Impact

1.2.1 Unconcerned with research impact/management implications

- If I was going to do this research and put all this time and energy into whatever I discover, what’s the point 
in doing that if it can’t be used by everyone/anyone? What was the point in doing it? The researchers who 
just want to do the research and don’t sort of really care beyond writing their paper and having it
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published, what motivates them to do the research in the first place? Personally I think that’s a good idea that the researchers are getting a bit of pressure to make sure their work has an impact.

- I don’t think there’s feedback within scientists or scientific institutions to reflect on what their work means in terms of management implications and the communities they work in.

- Scientists are outcome driven as opposed to process oriented. You can have a really crummy outcome, but if the process was good, people will look at the outcome favourably, and this premise isn’t valued by researchers. I guess it comes down to dollars. Say you don’t have enough papers, or the model isn’t finished. But if the process was good, it could’ve been informing how decisions were being made, it could’ve resulted in a new community group that’s changing how things are done. But research isn’t evaluated on these things, in community terms, or real world gutsy stuff. These are the uncertain things that people don’t know how to monitor, but they’re what is important. It’s great to have lots of publications, but what does that mean in the real world?

- The researchers aren’t the ones to put research into practice, but I think we’ve got a responsibility to help in the process of translating – I don’t think our jobs end here, but its not part of our mindset.

1.2.2 Lacking strategies to put research into practice

- It’s partly the magic of hindsight, but what came out loud and clear in the last symposium was that there is a need to start thinking about all this knowledge and what we do with it. That’s a fault of early planning processes for the research projects.

- What’s absent is thought around the life span of a project which is thought of in static terms without being responsive to the realities of putting research into practice. It’s critical that the cluster get the research into terms that have meaning to people on the ground.

- It’s been a great research effort and really impressed with it – just don’t want to waste it now, that’s my big, big concern. If the end result of all this research is just “more research please”, I think the government will stop funding research in Ningaloo.

- Things are based on three financial years to develop and complete a project, and here are the particular outcomes we expect. It’s the presuppositions that worry me – how do you know what the outcomes are going to be? They talk about outputs in the form of reports, information sheets, etc. – static outputs –as opposed to what we’re going to do with the information. This leaves it to the community to do something about it

- It’s so big [integrating research with management] I don’t know how to do it. DEC has this social research unit now, and ideally research should arrive in DEC there and then go to the planners, who use some sort of framework that it all slots into. But it’s not an ideal world. There’s so much going on in Ningaloo, its difficult trying to find all the different research and what’s relevant, trying to provide researchers with appropriate information from a manager’s perspective, and then trying to link research into the management procedures for visitor planning, for example. It’s a big task, and there’s not a lot of time or many of us in terms of managers and people on the ground.

- The closest we get to translating knowledge into action is through communication strategies, but I don’t think we work past that. Communication strategies are critical, but the next phase is missing and needs to be built into the project. We can have all these ‘learnings’ but what are we going to do with them? It’s great if we communicate research to the community, but is the community left without support to implement the necessary changes? Is it just resting on the shoulders of government to implement things top down? What about a bottom up response? How do we involve the community in deciding how we’re going to use these learnings?

- I think what happened with NW Shelf, which didn’t live up to expectations of research being used for management, led to worry about how research in Ningaloo will be used. There is expectation, now at the end of the project, to see research impact. I think it’s political in that people are worried about getting their hands slapped if there is no demonstrated impact from the research. This has created an impetus to step
things up in Ningaloo. I think a lot has been put on [redacted], she’s an exceptional person but there’s only so much one person can do.

- I believe the scientists knew they had to have some sort of management impact, but they didn’t necessarily know how to do that or who to ask for help. Scientists may say they’re going to do communication in their project proposals, but actually doing it is another thing.

- On the other hand as a fairly junior researcher myself, it is hard to know how to navigate your way through a process like this. I sometimes feel like I haven’t been given heaps of guidance about the use of my research, about whether my research is expected to have a use, and if it is expected to have a use, to whom and is it my responsibility to shape it so that it’s useful.

- I’ve come from an arts background, a discipline where I’m not accustomed to having to have useful research outcomes – it’s a sort of philosophical discipline. So having to have management outcomes was a new concept to me, and I haven’t even really been briefed that my research has to have that. That’s been new to me.

- I will send that summary around and I will do some things like that to ensure the people know I’ve finished and that the research is out there available but I mean it’s not within my scope to kind of go out conducting workshops and shaking hands with everybody and explaining to them… I guess that’s where CSIRO may have envisioned their role to be with this process, to be that middle man, that interface, but I’m not so aware of what that interface is.

- Now the question is, what are the questions this research actually raises, and who’s going to answer them. It’s ok for us to have the knowledge but what do we do with it? What does it raise and where do you take it? Where do you spend it?

- Yeah, it’s amazing how the money we spend on research…the first thing a few people said last night is ‘what’s going to happen with [redacted]’s research’, ‘oh, it’ll go on the shelf with everything else’ and that sums up people’s attitude to research. If they don’t think that anything’s an outcome from it.

- When scientists are forming their research questions they’re not necessarily looking at what’s relevant and meaningful to the place they’re working in. And once they’re done their research, they often stop there, rather than explore avenues to see the research used, communicated or otherwise translated into policy and practice.

### 1.2.3 Lack of relevance to operational/pragmatic concerns

- I think some of the research questions were raised by WAMSI when they were developing the management plan, and are fairly strategic, conceptual large scale questions. We mainly deal with people’s activities conflicting with natural values: e.g. people driving on beaches they shouldn’t be on, disturbing turtles, swimming with animals. Although there is more strategic thinking in conservation and some of the research is more understanding based – where do the sharks go, etc. – that type of research does not have direct implications for us in what we do day to day. I can’t see immediately how some of that knowledge will have implications for us, or be used by us. It has to be more specific to help us manage day to day.

- As the district DEC office in Exmouth, we’re the pointy end of the organisation, on the day to day front. Some of these positions get involved in strategic stuff, but mainly we implement programs that the department runs. I see all of this work as really good for the review of the management plan, for the planning side, but I think for it to be really integrated, that knowledge needs to be applied by practical planning type people who’ve got the time to work with the information, to plan into the future. From my side, there are a lot opportunities I would like to have seen addressed that weren’t, in terms of the research topics. Every time I tried to talk about the research we were interested in – this is part of the problem you get when you’re dealing with strategic people in Perth – they see these as pissy little problems. But that pissy little problem is the real problem for me. My problem is all pissy little problems, all along the coast: just those little 4WDs going over the back, just those ATVs cutting through those dunes, just that site which has a break in the dune, all those little issues we deal with everyday, they’re
immediate, they’re real. They’re not predictable and they’re cumulative. They have potential broader ramifications. For example kite surfing is a fast growing sport. There was a report done by a turtle expert saying we have the only known mainland turtle mating area at Jurabi Point, with 120 or 160 turtles mating there. The females need to come out of the water while the males patrol. In October, at the same time, Jurabi is also a great spot to kite surf - immediate conflict there. I haven’t been able to get a student on to that, but to me it’s a real issue. I can’t address it with the kite surfers unless I have some information to show there is actually an impact. That’s where I’d like the science – someone needs to sit in the dunes for a month and observe movements and responses. We’ve even worked out a rough and ready methodology for our staff to collect some data.

- Like the Turquoise Bay issue with the currents. When you talk to most people there are always bigger issues. When you’re from Perth, you look at survival of the species or protection of the reef. You’re not too fussed on that site specific stuff - its just a site in the bigger picture. But here that’s what we deal with – the sites.

- So our operational needs weren’t necessarily addressed in this research effort. I’ve had opportunities to be involved, and I’ve tried as much as I could, but there were bigger questions in the management plan which was driven at a much higher level. I was involved in the development of NMPMP, it was a very scientific approach to management done by the marine science program. It’s a very objective approach, using a risk matrix, values, threats, etc. Some of the stuff that came out of it I didn’t agree with. For example, manta rays and whale sharks weren’t given high value because they’re not globally threatened, and the strategies are ranked according to the threat. However, in Coral Bay the emotional attachment to theses species is huge. There’s a community who want us responding to what they see to be an immediate threat to a mantra ray, which is a beautiful creature, but from a science perspective that single mantle ray isn’t important. But it is a real issue for these people, and it should be rated higher. However in an objective, rationale science based approach to developing a management plan its not.

- Although the research classifies the landscape and says this is good and this is bad, but it doesn’t necessarily result in what we need. They might say an area is unstable and we shouldn’t construct anything, but what if there’s a recreation site right there, that’s popular with Coral Bay locals. If we try to close access to that you’d get lynched. That’s the reality of it. So the research is nice, but in this particular case we have a pastoral lease on one side, so we can’t use that, and you can access along the beach, but it’s a turtle nesting beach. So come turtle season that’s out. So now we have tracks coming through the dunes. How do I deal with that? Even if the geomorphology research says the landscape is not suitable, that it’s unstable, you’ll just need to close it, I still need to deal with and accept that it will be a high maintenance location.

- The Ningaloo Coast strategy looked at early work was done on stability of coastal landforms and use patterns, and from a landscape management perspective identified areas where camping is happening on unstable dunal areas, and said we don’t really want people in these areas, we’d rather have them geomorphologically suitable areas for development. If you travel to these areas, you see that the geomorphologically stable areas are limestone, and the limestone shelf carries on into the ocean. People have tinnies but we don’t want them anchoring on the limestone shelf because you can see little turtles feeding on that. So at very low tide you won’t be able to move across the shelf. So what do you do with kids? You get in a car and drive to the beach 2km away. People are camping where the limestone is, but are now driving to the beach. So now you need a car park, and you’ll still need a construction. Isn’t it better just to put the camping at the beach and live with the fact that you’ll have to do more stabilisation work and that it’s a higher maintenance site. Because its where people want to be.

### 1.3 Problems with communication and attitudes

#### 1.3.1 Problems communicating

- Researchers or scientists, by their very nature, talk in a language other scientists can understand – not what Joe Bloggs can understand. And then Joe Bloggs uses that as an excuse.

- Researchers use different lingo and relate on a different level.
Scientists don’t all believe it’s their responsibility to translate their work into community terms. They don’t see it as their role, or they don’t have time, or they don’t know how. They don’t know how to do certain things, like communicate or run workshops, so they disregard them, rather than asking someone to help them or to collaborate with. I don’t know how to communicate, so I’m not going to.

You have some scientists who can talk to anyone. But they’ll eventually leave their role, and you can’t trust the next person who fills that space to have the same interpersonal skills. You need to somehow work around personality aspects – which becomes a bit structural.

We don’t have the resources to engage all the scientists – you may not want to do that anyway, because not all the scientists are good communicators. You want people who have a passion for the science to translate it outside their area of expertise.

1.3.2 Attitudes

It’s like the researchers are in this little world and you find it very hard because they’re on a timeline and a deadline and they find it very hard to step out of that.

I’m not a scientist, so I don’t have any weight in the scientific world.

It’s not just having the right language that’s important when dealing with scientists, being from the right background, I think, would be more important than the right language. I can learn the language, I can read that management plan, learn the words and spit them back out again, but I’m not a true scientist so I don’t have any weight in the scientific world. There’s no question, that’s the way it’s looked at – if you’re not a scientist, you don’t know.

The scientists we find on the ground are usually pretty good. It seems to be the ones further up the ladder, they’re more political.

There’s also a bias that you have to have people with Dr. titles in some jobs, and I experienced that myself when the project set ups were happening and I was asking about opportunities. I was basically told you need to go and get a PhD and there’s no future in this area unless you get a PhD. I thought, well is that what it takes? So I’ll go and research eye cells of a fish, write a thesis on it and afterwards I can go and start implementing major strategies related to management? Get real, it doesn’t make sense. But there’s that bias that you get from academia. If you don’t have a doctorate, you’re not in the club. You obviously don’t have what it takes, so that’s a limitation in itself, and maybe I have some personal views, but I’ve experienced that several times myself.

1.3.3 Idealism

Like our turtle program. and I have discussed it and set it up. Now these volunteers are trying to change everything around, telling me they need two cars, they need this, they need that. I tell them they’re not getting it. You get what you’ve got already, you’re not changing everything. They’re scientists, yet they’re not - they’re kids that have finished the first section of their degree and have never lived in the real world yet. But I would have to say its more scientists than age.

Part of the issue is interpreting the data to make it relevant to us. Students are often not embedded in our operation, so they get side tracked. They’re academic supervisors pose academic questions and the students get taken away with the academic questions, and they’re not confined by the realities that we deal with in terms of political acceptability, frameworks, etc. So you get recommendations that …well that would be nice, but you want to me to act on that? On what basis? Some of it becomes subjective, and the evidence just isn’t strong enough to make a case. Remember, someone has to go and argue that. Its easy to put down recommendations, but someone actually has to put it on their shoulder, fly the flag and run it through the opposition. I put a lot of value on having students in there, but I often think they’re too removed from where you want them to be. It’s getting a better balance between academic supervising and doing things for management. Philosophical versus a more pragmatic application.

[when you talk about research students coming in, doing a project, and coming up with recommendations that aren’t practicable, do you mean the research had the wrong focus and isn’t useful, or do you mean
they've come up with unrealistic recommendations based on that research, and it would have better to write something up in collaboration with management agencies that is realistic? For example, wildlife is a strong emotional attachment for a lot of people. Like whale sharks and dolphins— you can’t touch them. But when you stand back, feeding the dolphins for example (the common bottlenose dolphin is all over the place), if one dolphin dies at 30 instead of 40 because its been fed too much, it doesn’t really matter in the bigger picture. But other people say you mustn’t and that individual must be saved at all costs. We have that issue with wildlife carers and the amount of road kills. Animal welfare is different world, and we support that too; it’s an important charter for us. But there are also tradeoffs. Some studies take idealistic positions. The manager has to make the tradeoffs and balance a whole range of different factors.

I talk about presentation values, I look at dolphins and whale sharks, its the value of people having those experiences. People think the whale sharks are being disturbed, that we need a higher level of compliance. Well are people disturbing them? Maybe some animals feel harassed but the value of people having that engagement is important. But you need to be there every day, some say. But for us to be there everyday costs money. There’s 15 boats spread out there, that means we need 3-4 staff to be out there. The researcher has made the recommendations, but is the impact really significant? For example every year foxes predate turtle eggs. People get very upset, volunteers do a lot of the work and they see turtles nests dug up by foxes, and I still get very upset when I see it. But standing back, we’re collecting data on it. We’ve got an 80% confidence method where we look at the total number of nests being laid and how many we lose. Our target is less than 5%. We basically get under 5%, there was one beach that went to 8%. That’s the target range. We accept with the level of effort we can put into it that we can reduce predation from 70%, which is what we initially counted, down to 5%. But when you have 7000 nests, 5% still means 200-300 nests. So when you go out for 50-60 days on the beach your going to see two or four nests dug up every day. That looks horrible. Shit, we need to do something about that fox, try to catch that one fox, night after night. So $10,000 to chase one fox? Does it matter for the species? Because there used to be dingos—the’re not there anymore, we have to remember there are other predators that have been displaced. So I’m just trying to illustrate that emotional attachment to outcomes from an insular position. Ghost crabs are another example where people have gone very extreme and started to illegally collect and destroy ghost crabs enmasse. But first of all we have to actually prove the ghost crabs are a problem. Even if they take 80% of the nests, the nests are still here today, the ghost crabs have been here for a long time. Show to me that the ghost crabs have proliferated due to some human influence. No one is showing that. Again, people jump to one end and want a response, but they say 1 in a 1000 turtles die, and maybe 800 of those die on the beach, so we don’t do anything about that because its all natural.

1.3.4 Lack of acknowledgement

- Problem is with a lot of these researchers as well, they like to make a name for themselves so they don’t acknowledge who helps them. Not even a thank you.

- It’s been happening with one researcher here for the past 10 years and now it’s come to a head and a lot of people are refusing to participate in his ongoing research, and he needs participation. Without the charter boat industry, his research wouldn’t have got as far as it has, and never a thanks, never an acknowledgement.

1.3.5 Not following rules

- There’s been a problem with a few research boats out there as well. They trying to jump in on a whale shark when you’ve got 20 customers waiting to see this whale shark. They just come along and don’t obey any of the rules and jump in. That was the attitude of the researchers. They weren’t abiding by the rules and regulations. They thought they had the right of way and were interfering with commercial operations. A few tense moments out on the water there. [So how did that get resolved?] DEC resolved that. Well, they break the rules and regulations so it’s pretty much revoked their permit to conduct research. The charter boats would be going and having a word with them, because it’s big dollars, and if they jump in and tag a whale shark and it dives and there’s 20 customers waiting to see it and they don’t even get to see a whale shark, then there’s $10,000 that you’ve just blown.
1.4 Scale and uncertainty

1.4.1 Lack of site specific information

- I need the site specific stuff. The other example is coral health and distribution. One of the criticisms we get is that in a number of sites we're managing people are destroying the coral – they're standing on oyster stacks, they're standing on the coral, and coral is being destroyed by people snorkelling. So we're currently setting up a monitoring program. When I talk about these site specific issues with some scientists, they say well on an ecosystem scale it's not an issue. I agree – if coral at Turquoise Bay cacks it's not going to be the end of the world. But its presentation value. In Queensland World Heritage we had presentation value. When it becomes a value, it becomes something you can manage. Here it's not a value – it's a recreation site and we manage that, but presentation (landscape, seascape, nice coral) is not a recognized value. Ecological communities, ecological functions are values, but presentation is not. In the Great Barrier Reef presentation was one of the values to manage. Obviously we're not going to let the coral go, but I need work done at the site specific level to find out how that coral community is changing over time in relation to other locations. At Oyster Stacks we now have more visitation – is that changing at the very local scale relative to other locations? Some of the research is too broadscale to address that. Ultimately there's a broad landscape scale impact or management tool with the zoning system for the marine park. But at the operational level its about impacts in very specific sites, e.g. what are the impacts of concentration of fishing in certain areas? The questions I have are always much more directly related to activities of people. We get broad scale numbers of visitors from the park's work, but what does that mean to Turquoise Bay. It's up to 800 visitors a day in the peak season – what does that mean? Is that a problem? Oohh its overcrowded – well that's perception, it's a different question. An Australian will say I can't go down there it's full. But there's still spots to sit, it's not full compared to European beaches or Sydney Beaches, where there's a few centimetres between towels. Everything becomes a question of relativity. So does 850 people mean that's enough? Does that mean the coral is being damaged? Does that mean the quality of the experience is no good?

- The most immediate thing it means to me – which we were aware of before the research – is the car park is full and people are parking on the side of the road. We already know that. The question for us is how many more car parks are we going to put in? What's the experience we're trying to preserve? Again, coming into very site specific issues. Where we sit in the District, the questions are always much more site specific. And planning for the future: where do we create new sites, and the access to these sites?

- You come to me, and say: how can you use this information. I can't influence the planning process; I need to know about site planning, where can people drive on beaches, where camps are going to be. Can you develop a model that tells me what's going on at Turquoise Bay? Can you tell me what's happening with the coral at these sites so I can do site planning for moorings? What is the depth and distribution of those coral communities? How important are those habitats? Can I make them anchoring areas? That's what I need in this job right now. Planning models for tourism, well the Cape Range Management Plan, if it gets signed off by the minister, its with her right now, will double the number of camp sites. Well, model that. We're going to have twice as many people in the camp sites. It's going to happen. Every day one person leaves the park at 8:30am and we've got 10 people waiting at the gate. Yes we're going to double the numbers that go in the park, but 10 years on we're not going to double them again. We're going to have to start thinking past that. Some people think we're stealing all the customers from town by creating more camp sites. Why can't people drive 150 km return trips every day to go for a swim and then stay in town and use all the utilities? Why are we taking all the business away from the businesses here. Well because people want to be here, they don't want to be in town.

- The reality for me will be: Ok Turquoise is already full, we're going to build another car park. Now is science going to answer that? The only thing it'll answer is well you're going to have more people there. Well already they're parking next to the road. Do we book them? What's the point because most of them come from out of here, it won't have any management effect because. They'll get pissed off if you book them, but the next lot will still come, because they're not the same people coming back again. There's no learning there, so there's not much point. Management controls will be brought in, they'll cost us more
money, if we have someone permanently there it’ll cost us more money. That takes away from other services, so that’s all management stuff, I don’t see how the science helps.

1.4.2 Error and uncertainty

- Some science is very straightforward and experimental and linear, but the science becomes limiting when it goes into complex systems. So you look at some of the science constructed on a whole range of assumptions. Each assumption in itself has a level of error or uncertainty, so if you say that’s 95% confidence, but some of the marine science stuff is so complex, that error gets compounded and confounded over so many assumptions, each kicking 5% variability in, you actually end up with quite a broad range. After a while it really starts to waver where you could be going. People sell things as certain because people are looking for certainty.

- There was recently a good paper that looked at research and saw it broken into two philosophical camps. One utilitarian, which lines up with the fisheries management approach, then another with a more emotional attachment, which tends to be marine protected areas, etc. The research on both sides has pros and cons. The paper compared them and found them almost level, arguing that its really a philosophical divide, and there has to be acceptance on both parts ultimately that yes there are issues with marine protected areas. I’ve recognized that myself. Some of the sites do very little: you’re better off having made a no anchoring area, you would have much greater protection than putting in fishing ban because it’s too small. But most people can’t handle that grey area, which is why they tend to go religion and like things black and white. Its easy, it creates a very straightforward set of rules outlining right and wrong. I think a lot of things in life are much more complex than that, but a lot of people can’t exist in that complexity. So with science there is stuff that comes up and says this is what I’ve found, it indicates that something is happening but i can’t say with certainty, another study may be required, and we don’t have money, etc. And other people who have a vested interest against that dig up something from somewhere else, and say this work over here found something different. So people tend to go with their gut feeling.

1.5 Issues with models

1.5.1 Lack of long-term custodian

- Can you see that happening? [model being used by Shires, regional planning bodies, etc.] won’t be available in 3 years time, to crank up the model when we ask her to run a scenario. Who the custodian of the model will be remains unresolved and this is critical to its use over time. Even if the model is wonderful, someone will need to keep it up to date and know how to use it so that it continues to be useful over the longer term.

- So who’s going to look after the research? If this is worth doing, it’s not point-in-time research because you have to keep it up to date, to keep it alive. So who’s going to keep it alive? When you get right down to it, the people who are really committed to the place are the people who live here and so they should be the ones. But if they don’t know enough about it or understand it, they’re not going to do anything. In some ways, it’s organisations like us that are quite limited in resources anyway…and no one’s saying: can you keep our model alive. It’s all still a bit of a vacuum there, you know?

- Prior to the project completion we’d run an engagement process with whoever will have control over it, to hand over the information and model. But it’s fraught, because the model isn’t vested in an ongoing research centre such as [model's name]’s model is.
1.5.2 Lack of availability and relevance to locals

- If the model is not available to the common person, then what happens to it? Does it sit in a paper somewhere, archived for eternity and no one knows it’s there or can actually really use it? I guess that’s the problem with models and a lot of planning stuff as well, it’s all pie in the sky. It comes down to getting the value out of it and using it. I reckon that’s an absolute key to a lot of planning and modelling work. It’s fantastic doing it but if people can’t use it, what’s the point?

- The idea of the model being handed back to stakeholders is all well and good but do stakeholders even want a model? Who came up with that idea that a model is what is needed here? Do the managers of this caravan park actually want a model? I simply, honestly don’t even understand... is the model a software package or what is it, is it a diagram that I would receive on paper? If the Shire president here was, great, give me the model! What do they get? Do they get a CD? Do they get a piece of paper? Do they get a book with charts and tables that are outcomes? What actually is the model? When we say that the model will be handed back to stakeholders, what is it? I don’t think anyone knows that up here.

- So all the modelling in the world may be well and good but if it’s not going to allow people to come in and spend money here and create jobs, you’re wasting your time.

1.5.3 Lack of uptake by agencies

- With Management Strategy Evaluation the research is funnelled into a model which can be used to ask management questions. My impression is that this is something that managers aren’t familiar with, so it’s taken a long time and repeated messages for them to get to the point of seeing how it is useful to them.

- It’s been a challenge for us to get managers to ask questions for the MSE model so we can help them do management strategy evaluation. There’s been a lot of meetings and not a lot of progress, starting even before this project. Not everyone is convinced MSE is useful – that complex computer modelling will give them a robust understanding of the world; there’s been a bit of controversy there.

- It appears to me that the main challenge for MSE model has been in convincing managers to accept, understand and use the method. It’s something that’s fairly abstract; simulating management of a virtual world, and using that to develop intuition about the real world. The research in Ningaloo is dealing with complex systems and problems. How do we do sustainable development of the coast? This integrates society and nature, and requires the use of relatively sophisticated models.

1.5.4 Too complex

- The MSE model is a difficult one, it seems to be trying to do everything.. This is a second attempt at it in WA. The first was the NW Shelf, which promised the same thing, overarching economic/environmental consideration. We brought it in then because regional development in the Pilbara was out of control: ports every 50 km and railheads everywhere, dredging everywhere. So our idea then was let’s try to develop this generic tool. We were also predicting that the Kimberley was coming on line and we could use it up there too. But that dream dissolved because you couldn’t control the complexity. I think things have moved on a fair bit since then, and hopefully this one will work.

- A very simple model potentially might be used. We’ve had meetings with [redacted], and we’ve brought the planners and operational staff in, and she’s said what the model does, and we’ve told her very clearly, there needs to be some sort of simple interface that takes all the complexity and reduces it down to a few key switches. She understands that, but whether or not it can be done, I don’t know. It seems to be getting more and more complex and more and more global, and I see it drifting more and more from our reach. It’s more of a regional planning tool. Hmmm – fair comments, but do we want to put this out there???

- When you deal with modelling, the difficulty is not preparing a shopping list of all the things you can think of will happen, it’s making the decision on what is the important stuff and what is not. That’s where you can distinguish a good modeller from a bad modeller. A bad modeller will try and include everything in his model and spend x number of years to make up something, and then at the end, the people disengage and the model sits on the shelf. A good modeller will know how to focus on the most important parts of the
system and make a decision, ‘well I’m not going to touch this or touch that’ because it's either too complex or not really accurate, or whatever. So for me, a good model is a small model and when it gets to a certain critical size it becomes near impossible for not only any end user of the model but even the modeller for himself or herself, to get a grip on what’s going on. At this stage we should really have a special shortlist of important questions for the model. It might require a scoping exercise.

1.5.5 **Don’t reflect real world complexity and bureaucracy**
- I’d hate to think of the people who put the plan in for the pub at Coral Bay or the people who did Maud's Landing. How many millions of dollars did they spend and then it all got kicked out. If that's not in the modelling…well I’d say that the model’s just not going to be relevant to getting the place up and running.
- If they want to use the models to look at what happens if they change the development nodes on the coast, they’ve got to get past Native Title first. You’ve suddenly got another full stop there. It’s no good me using the model and saying, well, if we could shift the Red Bluff node 3 kilometres up further north, how many extra people can we get in, how much increased revenue etc, because you just can’t do it. So all these full stops need to be put in. People need to know what they can and can’t do, and at the moment they can’t do anything.
- And that comes down to the planning red tape and bureaucracy. If you want to drill down further, it comes down to the individuals in that department who are doing more than what their job description tells them to do. They put their own opinion into the process so it actually comes down to personnel. If they ran planning in black and white by the book, I don’t think they’d be any dramas. How do you put something like that into a model, you know, personnel? I don’t know how the public service can get over that, to make sure that before they employ anybody straight out of uni, I know it’s a bit of a generalisation, but they have to have some actual practical experience out in the workforce.
- A concern would be if the models couldn’t deal with wide proposed scenarios.
- Modelling is an attempt to kind of understand the world as a mappable knowable entity. I just think that it's a flawed idea to be able to say we can map out the world in a knowable. I’m like…you could model Romeo and Juliet and it would be like, Juliet, positive feedback looped to Romeo, has positive feedback looped to Juliet, parents have a negative impact on Juliet...like I mean you could but it sort of misses the detail in life doesn’t it? You could run the model and predict what would happen in the plot of Romeo and Juliet but do you think it would work? Well it’s just not how I like to think. I guess I sort of think about language and feeling and things that models don’t pick up. Doubts and anxieties aren’t reflected in models. Models are just in terms of negative and positive feedback. To me it’s just not my thing, with not to really diss the whole project but it’s not…i just try very hard to be enthusiastic about the model but every time somebody talks to me about it I kind of go (snore), you know.

1.5.6 **Unrealistic expectations**
- Got to be careful with these models because some businesses will plug in a question and it'll spit out answers, they’ll go off and develop their project according to the answers that have been spat out, and then they will turn around and say, hang on, you said if I did this, this is what would happen and now it hasn't happened.
- The smarter businesses will use this modelling information wisely. The less educated businesses will see this as a crystal ball and will take it as gospel. That's got to be in bright red at the top [of the modelling fact sheet], that the models don’t predict the future. Otherwise operators could say oh, but they said it could do this. It just has to be a warning on the front page, a huge warning, and even an acceptance to use this model. The first page would be ok, ‘I have read that this is just a model, I agree to the terms and conditions to continue on’ and then you continue on through the website.

1.5.7 **Lack of trust**
- Isn’t it the modelling process that’s supposed to be doing this [providing the interface between research and management]? The modelling process has got very noble aims. It’s supposed to be this tool that is developed that can be handed back to stakeholders and stuff. But I guess the truth is from the outset I’ve
been pretty cynical about the modelling process. It's not my thing. It's not how I think. So it's just a personal bias in many ways…

- Not the model about how many tourists destroy the place? I’m flinching thinking about it. Ronny turned around to say she was very proud that I didn’t yell out abuse on that day. You’ve got an audience and you’ve got power, you’ve got power when you’re a presenter.

### 1.6 Variable research quality

- [Given the work that’s been done is there something the program could do to help make the research more usable for you guys?] It’s probably best to talk to people who work in different programs directly. I could certainly see that some of the work, like the sustainable camping, could be interesting. But it depends on the researchers’ background. …if you get a good person, you get a brilliant job, you get an average person you get a passable job, but you might not get everything you want. So will it be useful? I will always look at the work, but I don’t just take the outcome at face value, I look at what they did, how they did it. And if I have questions about the methodology I will start to challenge the outcomes. Personally I won’t be sure about the conclusion if I’m not sure about the method and how it was actually developed.

### 1.7 Ethical issues with sharing data

- As a junior kind of researcher, it’s sometimes hard to navigate your way around ethics when it comes to sharing information. It does make me feel a little cagey about discussing my work. For example, in order to get my ethics application through I put in my application that everyone would be anonymous. That gets quite hard when you interview a station owner, cause it’s hard to preserve their anonymity. But if people are saying come and share your findings with us, cause it’s hard to preserve their anonymity. But if people are saying come and share your findings with us, I have a sense of like, ooh, um, yeah, well, err, I’d like to kind of but I still haven’t worked out this issue, like if somebody says to me what have you found in your interviews with station owners, I would sort of have to say oh, err, well, I’ve just spoken to err, one and he or she. Maybe as a more experienced academic it’s easier to find your way around those issues, but as a junior, they’re a barrier to opening up.

### 1.8 Too many/overlapping researchers

- I don’t know how much discussion happens between the different research institutions, e.g. making sure the ocean current research relates to the landform research, and track rationalization research relates to vegetation research and information. Researchers should make sure that any overlap between their projects is looked at.

- Has [REDacted] spent much time in the area? There’s that many people that come through, you can’t keep track of them.

## 2 External Barriers

### 2.1 Issues with agencies

#### 2.1.1 Staff turnover

- The agencies are harder in some ways is because there is so much turnover – the people I’m talking to often change every 6 months – just as they start to get it they leave.

- The biggest issue is high turn over in on-the-ground agencies before the stakeholders are engaged in the research. Once stakeholders are engaged it becomes the way things are done, and they look for the
information and advice. It’s a lot harder to maintain long term contact if the stakeholders aren’t looking for it.

- [The average time a Shire or DEC staff members stays in the North is 2 years. How do you build longer term relationships and informal networks between researchers and managers?] I don’t know what the solution is. I know a guy in Spain - he is the one who gets all the phone calls, he knows everyone, everyone knows him. I think he has more effect on management decisions than anyone else I know, but he’s been in the same place for years. My next project is in Sydney.

- One of the big issues in these Northern Regions is staff turnover. Two years up north is a fairly standard timeframe, slightly longer in Exmouth. Regional managers and Parks and Visitor Services leaders have a significant turn over because of challenges of the north. The communication has to be done fairly regularly, resourcing of interaction and conferences in tight budgetary times is very difficult.

2.1.2 Model training and agency turnover

- [Do you think there are people in the community who are here for the long-term and who could play a role in seeing the models used in the region?] To be perfectly honest, no. For example we thought we were going to be here for 15 years, and now we’re leaving. You just don’t know what’s going to change. It would be perfect if there was someone locally but I just don’t think people stick around…particularly people who work in government. Obviously a lot of the research is related to the natural environment so my thought would be someone from head office in DEC to coordinate, manage, be trained up in the models…but then again their turnover is probably high too…it’s the whole career path thing isn’t it? And I would imagine that being trained to use one of these models would be quite a full-on extensive process wouldn’t it?

- I think if they can project the model and make it functional, it would be fantastic. But I do think that the turnover of people here is going to be problematic and it’s virtually impossible to predict who’s going to be here and who’s not.

- I think the funding is probably going to be an issue [with respect to ongoing access to models]. Turnover of people in the local agencies is going to be an issue. You might train somebody up from the shire but there’s probably a pretty high chance they will be gone in 12 to 24 months. So how does the ongoing training work? I guess it is too complex for people.

- They talk about the model but the model is just a grouping of thoughts and stuff. I know that there are statistics, there are pages of it, but is anyone here trained to use a model? Does anyone give a shit? Honestly, I don’t actually understand it and I don’t know if anyone else does.

2.1.3 Lack of time & resources

- I expect that I will be able to write up my stuff so that others can understand it, and it will inform their intuition. I know that state agencies in general (not just in WA), people are usually harried, and a lot of decisions have to be made by shooting from the hip. But that doesn’t take away from their ability to read and understand research – most are very able to interpret information from research, its often the question of whether they have the time to devote to problem at hand.

- It’s not just the delivered material being in the wrong format: resource management agencies are typically understaffed, which speaks to how society chooses to allocate resources to management of natural resources. Even though Ningaloo is relatively well funded, it gets just a fraction in comparison to the money flowing out of the ocean around there, in terms of oil and gas development, etc.

- DEC has a number of shortcomings, but they also suffer from a lack of time and lack of resources. So it’s hard to find a solution.

- This expectation that managers etc. will dig around for the research is a fantasy. They just don’t have the time, even if they knew what was there to look for. Managers don’t have time to trawl through and find research documents.
If the research is seen by the broader community as so critical, then DEC should also be resourced to interact with that research project. Because at the same time as trying to support research projects, we’ve got all our day to day management responsibilities, and timelines, and deadlines we’re working to.

We should do less projects better, rather than have so many projects going in various directions, and really make a good job of what we take on, and ensure they are strategically keyed into whatever issues DEC is trying to deal with at the moment.

But the time is the killer. I would like to see managers after 5 or 10 years getting 6 months sabbatical to allow them to come to other programs in the department. We’re allowed to do that, but work load to just do your job is so high that you can’t actually intellectually engage, because you’re not give the space in your head to do it. You don’t have time to think other than about the urgent stuff you have deal with. We’re in reactive mode all the time. Since I’ve been up here, this office has been in a continuous state of flux. We’ve had huge changes, management structural changes, and all that in an organization takes time and energy to absorb change and adapt, its not very responsive.

There was a PhD student who set up a process for a sustainable tourism model. He started to set up forums with all the stakeholders talking about turtle management and developing a model based on Kangaroo Island. He had about $120,000 of funding from the commonwealth, all really nice. But here’s an example of researchers not having to be responsible for the outcome at the end and walking away from it. I kept saying to him that’s really nice but you’re here, you can organize all these things, but when you go whose going to carry this? All your ideas of monitoring and the sustainable tourism model are non-resourced, they’re just things you’re telling us we need to do. To do all these things is another job, another full time person. This was a pragmatic PhD developing a sustainable turtle tourism model, but it interfered in some ways because it created unrealistic expectations. I didn’t look on flow on effects, it wasn’t limited by policies across the state in terms of agency implementation, inconsistency of what was applied here compared to elsewhere. As an agency we can’t just create things differently in different locations, you have to work in the confines of acts, legislation, etc. And the energy to do some thing, even great ideas won’t get taken up if we don’t have the energy. Sometimes we do things because that’s the best we can do with the resources available. And it’s a compromise absolutely. Yeah, I agree we should be doing a, b and c. Give me the money and we’ll do it. No worries. But in the absence of that resource, well… I’m not trying to stifle ideas, the ideas need to grow, but at the same time they’ve got to be grounded in practical reality. You don’t want to limit opportunity, but at the same time cynicism pops in over time, and unless you can lobby more money, your research isn’t going to change anything. At the turtle conference in February the researcher presented and noted that the changes hadn’t been made and what he’d set up hadn’t been carried on. But didn’t have the resources, we can’t – this is just one issue among all the other issues we have to deal with.

2.1.4 Loss of NSDO

NSDO was to be the receiving agency for all the research that’s been done in Ningaloo. The new Gascoyne planning body is being set up, and there’s intent to continue planning strength through it, but there will definitely be a lull in period while it’s getting started. The NSDO has provided input on what the new planning body should look like. The government recognizes the work of NSDO in implementing the Coastal Strategy, but where it goes from here is still a little up in the air.

Although the new Gascoyne planning committee has the potential to do what the NSDO did, it has no resources and no office, so it’s uncertain whether it will be as effective.

The other thing that has changed significantly is the loss of the NSDO. The NSDO was the body that effectively applied higher level strategic planning to the future development of this area. We’ve now shifted to towards a very pragmatic, on ground power base. He goes directly to councils and Shires, the GDC, They’re not really people who are strategic, they just go out and support projects. They’re project based as delivery agencies. That’s what wants; he wants the rubber on the road, the projects that the community wants up and running. This is what the community wants so the community is going to get it. This is different from centrally based thinking, where people sitting in Perth are going through their daily lives in the city and they’re pondering the future of all the places that they go.
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and visit and enjoy, and all the things that need to happen. But they don’t actually live there. That’s why Labour lost support in the regions. I can see the planning, the big picture and where it was going; I was in favour of it. The NSDO, the research, WAMSI, was all created under a labour government by Dr. Geoff Gallop. There was leadership there from someone who’s thinking at that level. I think we’ve moved away from that.

- [If you had access to the model it might let you know how changes in numbers of beds in town might affect the park.] The Master plan for Vlamingh Head, etc. are all processes where this information would be useful. Again the NSDO was the body doing that planning, but it’s been disassembled. It’s going to be replaced with the Gascoyne planning commission office. I’ve got a letter that says it will happen. I have heard nothing, I don’t know how it’s going to be assembled or whether money is going to be put specifically to it. My expectation will be that it will exist in word, with loads with existing bureaucrats trying to deal with planning in a loose focus. The whole idea of the NSDO was people who were focusing the planning on what needed to happen. And they needed that knowledge. The problem is the knowledge and the models are there now, but we no longer have the frameworks in place.

- What I see as the issue now is the ‘who can get this version of the model in the region really’ because NSDO was the obvious place. Now they’ve gone, it’s really very hard to say. If we don’t sell the models in this round of workshops, we’re going to miss out on a key opportunity. Once the agencies we talk to go back to their day job, it’s all going to go phooof right to the bottom of the pile.

- The absence of the NSDC has left a big gaping hole – that role needs to be filled. While it’s being filled in a structural governance sense, it’s still not encapsulating the local presence that is required in its membership; but its early days.

2.1.5 Reputation

- We need to have the list of attendees as broad as possible given some departments, DEC in particular, have a poor reputation on the ground with people up there. If the knowledge generated by the cluster is channelled through DEC alone, we’re going to lose it.

- The problem is that there’s a judgement or a value that comes into that, that may then alienate people again if it is, for example, compiled by an agency like DEC who may put a particular slant on it. You’ll reach a wider audience if it’s not an ‘us/them, this is how it’s going to be from now’ approach and attitude.

- There is a very anti-DEC sentiment in town, and I think it’s a major hurdle because people are identifying researchers with DEC. Some people have quite a long standing, ongoing resistance to DEC, and they don’t seem to have that with the Fisheries Department or other similar departments. So I’m not sure how you overcome that but certainly if DEC were to present something, it wouldn’t be as well attended as an individual standalone presentation.

- DEC is shocking for not promoting itself or letting the media knowing about the good things that we’re doing. We just cop all the abuse.

- And it’s not to get the pressure off DEC, but you do feel it. I’ve only been with them for 7 years, but yeah, we cop a hiding. I’m employed to manage these parks for the public, not for me, not for my personal gain, for the public and for what’s best. And sometimes you get made to feel it’s your own personal agenda.

- There is historical animosity and I don’t think it’s Department related, I believe it could be personality clashes that have created these issues. Some of those people have been made redundant or accepted packages, so I believe it’s a change. And the models and the research and everything needs to come together more so than at any other time.

2.1.6 Modes of communication

- The biggest problem on the Ningaloo Coast and the simplest solution is the mode of communication adopted for information dissemination and decision-making. The current model often results in misunderstandings with negative results.
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- I guess it boils down to perception. Perception and not reality. Perception plays out in the formal delivery of communication and from there the whole pyramid implodes.

2.1.7 Lack of trust in private research

- I can see why you could be sceptical of private enterprise doing turtles, especially with what’s happened in Coral Bay where they were digging up the nests. There’s no doubt that that would make a conservation agency sceptical. But when someone says, ok, we’ll do it under your guidance, come and check up on us…our reasoning is let’s get the conservation up and running first and then I will get return on the flow-on after that, if it comes. There’s a lack of trust in us, no question. If you’d seen what we had to go through for the first year of the turtle stuff, absolutely frightening, it wasn’t going to happen. Well, we put in an application for a grant of $120 grand, and got knocked back on the first round. Then they had some leftovers and they said you’ve got $23,000. So we cut the whole program back and set it all up to run on that amount. Then we contacted DEC and said ‘We want to do turtle monitoring at the beach’ They said, well you’re not doing any interaction with them, what do you need a permit for, you’re just walking up the beach. We said, ok, but thought we’d better check. Then when the money came through we write a letter off to DEC to let them know, and they come back with, you can’t do that, you guys aren’t trained to do that. For a week and a half and they were going ‘No, we’re not giving you the authority to do it’ so then I got on the phone to the acting head at the time, and after three quarters of an hour they ticked it off. When the project was pie in the sky idea, it was no problem, go ahead. The moment it became an absolute reality they were going to stamp it out.

- I don’t know the exact reason why that would have been, maybe part of it through mistrust. But if I’m sitting as the head of DEC and I’ve got this guy down at a station who has employed a full-time environmental scientist, who has said we will get scientific people or PhD or Masters do this turtle monitoring - and I haven’t gone out and brought ten quad bikes and run ads in the paper going ‘Turtle Tours’, right - I’d have trusted him more. Although I’m doing the turtles because there’s a financial reason for doing it. Because if there wasn’t I couldn’t afford to pay for doing it. That comes through the African model of conservation paying for itself…true triple bottom line.

2.1.8 Uncertainty of land tenure

- I’m living in a vacuum here. I get copies of various briefing notes, I get nothing coming back. It’s a one way street of: this is our stuff, this is what we’ve been doing, what do you want us do? Our last policy was to go there. What do you want us to do? We keep going as we do over here, but things are changing, what are we doing? This is the situation. All I ever hear is Brendon Grylls. He’s not my minister but he has all the power. We have the land we’re managing, but outside that, all these other planning and tourism models, that’s not our problem. We don’t run Coral Bay; we just run the marine park. If we’re going back to this model, pffft, it’s not my issue, because I don’t control the number of campers on these leases. It’s not ours. Have we been engaged with it, but if the model changes I’ll let go of it, because it will just frustrate me to buggery, and personally I have my view about where all this leads, but that’s the political reality. And there is currently no counter voice that raises that. Part of the silence is everyone still expects that everything is the same. No one has said anything else. So why would it be. There can’t be any counter voices because no one knows any different.

2.2 Issues with community

2.2.1 Apathy

- The sad thing is that all these agencies come up from Perth, the Small Business Development Centre and so on and so forth, all organised by the Tourism Centre and the Gascoyne Development Commission, they will come up and give seminars for 2 days and 3 people will go.

- We find it hard enough to get people together for a committee meeting. Yeah, it’s ‘island time’ up here. And don’t have meetings at 6 o’clock at night, make it the afternoon. See if you hold things at 6 o’clock at night, that’s a hard time. Yeah, because people haven’t eaten yet and whether they’re going to finish this meeting to go and eat...
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- There’s a lot of apathy, particularly up here because if you look at why people are here, they’re here on many levels for quite selfish interests. They’re here because they love the place, but they love it on a personal lifestyle level. I guess, we’re going to get a bit more of an idea of it with World Heritage, but my feeling is that probably about 50% of the people who are here don’t necessarily want to preserve what’s here in perpetuity or for future generations. They’re up here because they can go fishing, they can go camping, they can drive their 4WD where they want. [But if they get a lot more visitors and development up here they might not be able to do those things anymore, so they shouldn’t they be interested in the research and modelling? They’ll get more regulations, they’ll get more restrictions, there’ll be less fish…] Well, I don’t think they understand that…they’re not being told that and again, that’s where the model might be useful because they’re not even thinking about that. I guess they’re hearing what the shire’s telling them, oh more people in town, better school, better health, more shops, Woolies, blah-blah-blah-blah-blah. So they don’t seem to be thinking beyond the ‘me now’ kind of focus and I think there’s quite a strong culture up here, it’s quite a selfish culture. And even like your tradies and stuff, they’re up here because of the surf…if you’ve got someone doing a job and the surf’s up, it’s not like they’ll show up to work or anything, they’re out panning the waves.

- I think it is quite an apathetic community. When there are opportunities to have input into community stuff, it’s a pretty poor turn up. With a lot of the stuff that the shire puts up for written comment, I’m the only person who responds. I think that just gives you an indication of how apathetic the community is, and it’s really apathetic. There’s another woman in town, but she’s leaving as well so…once you lose your key players, hopefully other people will step into those roles but somehow I doubt it. So yes, if you leave that sort of stuff with the community, I don’t reckon anything’s going to happen; it’s just going to sit there.

- A lot of these people here aren’t going to care about what’s going to happen in 30 years’ time because they would have sold their business in 10 years time. But I think the reality of Exmouth is a lot of people here are here because they love to go fishing, a lot of them don’t want that lifestyle taken away from them. But they’re not prepared to give up a little bit themselves in order to maintain it. There are a lot of redneck thinkers up here. It’s quite funny, you’ve got this little section of community that’s the conservation group, another section that’s the tourism arm, and then there’s the section that’s still into their roo shooting, and it’s quite bizarre.

- Whale shark operators - maybe this is a bit of a judgment, but I don’t think they’re too concerned with that sort of thing. I think they’re concerned more with the commercial side of it. I guess, they’re busy running a business, I can’t imagine them thinking ok, why don’t we try something different in the way that we our business, how’s it going to impact the sharks, how’s it going to impact the visitors if we do this… I don’t know that they’re that engaged.

2.2.2 Transient population

- Fish stocks have gone down. But the problem is the new arrivals don’t realise this, they think it’s great because they don’t know what it was like 10 years ago. There’s a funny thing with the transient population here. You’ve got people that are here for a year or two, and they don’t care about the bigger issues. I’m generalising, of course there’s going to be lots that do. But Exmouth is a funny community whereas somewhere like Coral Bay, that is a 100% tourism town, everyone there cares about the environment because their livelihoods depend on it.

2.2.3 Don’t like change or believe science

- And non-science people like to use that gut feeling: I know what’s wrong and what’s right. Its like smacking your kids despite all the research showing its not a good way to control them; people still say: rubbish, it never did me any harm. All the research on the impacts of hitting kids, I don’t need that knowledge, its too complex. People just go back to what they know and what’s convenient and comfortable; that’s people being creatures of habit.

- So what we’ve known and what we like to do we don’t want to change. So information that takes us away from that may mean we have to challenge what we ourselves believe, so we have to question what we’re doing. Some people do it really well – I went to uni with trawler men who came to uni to study resource
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management because they've seen things change and question it. Then there are others who say, well that's life. I think that's just part of the complexity of humanity, what drives people.

2.3  **Issues with regional vision**

2.3.1  **No follow through on visioning workshops**

- The issue with that [using the models for a community visioning process] is we’ve done those things and it doesn’t result in anything concrete. It costs us 3 days’ time. It doesn’t result in anything. There will be significant issues around which stakeholder groups you invite and represent in such forums. Personal views of individuals in a particular stakeholder group may also not necessarily reflect that of the whole stakeholder group. It would be very hard to include the whole community. I don’t think such a process is the most productive use of resources. In theory they sound good and are quite an interesting experience to have on the day, but it amounts to nothing.

- We’ve had two community workshops probably in the last 18 months, one was about the marina expansion and the other was this community visioning workshop, and in both cases the final product hasn’t reflected what actually happened in the workshop. So with this visioning stuff, you kind of go, ugh, where’s the real value in it? If it’s not going to be accurately represented and reported and written up… Ok you do the visioning workshop, then what? What happens with that?

- That community visioning workshop…I think that was supposed to direct the shire’s vision for the area for the next 5 to 10 years. Having said that again, we’ve been another process with something else where we spent a lot of time doing written input, none of it was taken on board. The same with the DPI, I think it took a lot of time to do that research and report and a lot of the time it’s not actually taken on board.

- In terms of that community visioning, community input – what’s the value in it? I think if it just sits with the community, nothing’s going to happen with it, and again I think that comes back to motivation versus apathy, and there’s a lot of apathy, particularly up here because if you look at why people are here, they’re here on many levels for quite selfish interests.

2.3.2  **Lack of cohesive vision for region**

- It’s really difficult because there’s so much planning and policy work done here over the last 20 to 40 years that identifies the environmental values of the area. Not just by one government but by successive, different governments over a long period of time. And yet now, despite all of that, it’s becoming an industrial hub and you’ve kind of got to go, what is the vision for this place? Are we going to become another Karratha or are we going to embrace what’s here and what is unique? I mean, you could have an industrial hub anywhere, we’ve got them all up and down the WA coast. Why are we putting an industrial hub here? You look out there now with all the FPSO’s and the ships in the gulf and it’s just like, what’s going on? I think that the political vision for this area has just been lost in commerce and its going to be a lot worse now I think with this government.

- I don’t know that much about the Ningaloo Research Centre. I think it’s probably a bit of a white elephant. I think the concept is good but the reality of it, I just can’t see it coming together. I think if the political vision for this area was still to embrace the natural environment and all of the fantastic marine stuff that’s here, I could see that that the research centre would work. But it’s not going to work with industry offshore. It’s not going to work with increased vessel usage in the gulf. It’s not going to work with Panamax bulk carriers sitting out there. It’s not going to work with oil and gas based here and fly-in/fly-out and all the rest of it. It’s a completely incompatible vision. The town’s either got to decide, we’re going to be this, or we’re going to be this.

- There was a community visioning workshop, and the shire president’s take on that was that the community wants development. I think everybody else’s take on that was the community values the environment. So even when they run a process like that, its skewed, completely skewed, and we did things like every group had to come up with what they valued about and it all went up on butcher paper around the wall – environment, natural places, wilderness – without fail, were the key values that people
had. Like there was just no question about it, and yet here you’ve got the shire going, ‘Oh you know, everyone’s pretty keen to see development happening,’ and it’s just like, ‘What’s going on?’ It’s just completely bizarre! But I mean what can you do – they’re the elected representatives and you’re fairly limited in what you can do.

2.4 Silos and lack of integration

2.4.1 Poor integration between groups and agencies

- You’ve got all these little silos of information just going their own way. The Government does what it thinks is important. The researchers do what they think is important. The landholders / managers do what they think is important and the public do as they believe is their God given right to do – and there you go!

- Effective integration of marine and terrestrial management hasn’t been looked at. It is thought the MSE model will help integration because it incorporates so many different elements and indicators, so management groups will be able to see how impacts go from land into the ocean. But how the management groups deal with that I don’t know. DEC marine and terrestrial planners have been invited to some of our things – some have showed up but not to all.

- Someone in Government told me that the sentiment is that “you’ve got to watch the bastards” and that is not the most beneficial way to establish supportive work relationships between landholders, tourism operators and Government.

- That’s where this leadership thing is so important. There’s got to be some sort of overlap between agencies, and in those areas of overlap the agencies have to make some sort of sense and try not to conflict.

- In terms of the future we need to ask: is the population going to double or treble in the next 10, 20 or 30 years, what are the tactical requirements for accommodation, where is it going to go, and what are the consequences of that in terms of the environment. Those are the essential questions that are not really being addressed because when the Shire, for instance, is putting in new development, they don’t even consider what the implications could be for the National Park in terms of increasing the visitor numbers. But that’s got direct implications. So DEC should be watching what’s happening with the Shire, and the Shire should be informing DEC about their plans so they can jointly manage the consequences of these decisions. Every decision these agencies make affects the others, so they can’t really operate in isolation from each other.

- It is a tragedy that the scientists in Perth fully understand this [how the reef functions and pressure from issues such as recreational fishing], that Government agencies have an appreciation of it, but you don’t see the research findings being fed out to the people on the ground, who then is not in a position to help you even though they would have had they been informed of the results. The landholders, managers and tourism operators are the hands feet and eyes on the ground. Every day, all day. If they know what’s going on they can divulge it down to visitors and the public, over which they have a lot more influence and contact than any of the Government agencies as they’re seen as a lot closer. An ‘us and them’ mentality between researchers, universities, Government and land managers is not helpful to this process.

- Some people might be concerned about being part of communications that includes/integrates other people’s projects – talking to them about this probably has to be done personally.

- [I’m thinking about stuff outside the park -- for example if the Shire wants to put in a 1000 more beds, this will affect the marine park. Is there a process where there’s some sort of integration?] It’s very difficult and it definitely needs to be done. The ultimate integrating factor is cabinet, so when the ultimate decision is to be made about regional development in the Gascoyne, the ministers come forward and say, well if you put another x thousand beds in Coral Bay, DEC says you’ll wreck a coastal area of x size, then DPI comes in says we’re going to have conflicts between swimmers and boaters, and we’ll need more roads and more power. Then cabinet looks at all this and says we’re the integrating the agency in all this, and if we get it right we get re-elected, if we don’t we get kicked out. That’s the current system.
Within DEC there’s a marine branch and a terrestrial branch, and links between them, especially visitor management, are not strong. They tend to manage the marine and terrestrial systems separately, when in fact these systems are linked; because the way the land is managed affects the marine environment, and vice versa. I’m not aware of any structures in place to integrate the two.

**2.4.2 Scientist-manager divide**

- When you talk to researchers, they often see their job as doing research, not making sure it gets used in management. Oh ok, well fair enough. So whose job is it to make it workable for the broader community? That’s interesting because obviously the managers don’t have the level of understanding that the researchers have, in terms of connecting A to B, but I can see why the researchers say that...

- The research would be of value, but sometimes it does become a question of not letting the science be influenced by someone wanting something because it’s more palatable, producing a report that’s less scathing of what we do. There’s a risk in that. On the other side you also get researchers who are often young and they’re very ambitious and righteous almost: I’m young and I know everything and you can’t tell me anything, and with the wisdom of the old, well that old manager doesn’t even have a degree, he doesn’t know anything. And it goes both ways, the old manager is probably thinking: young bloody upstarts, I never needed a degree, I’ll be alright, I went to the school of life. Between both you could get a middle ground. Sometimes the manager doesn’t allow himself to properly engage and learn from the outcomes, and the student doesn’t always engage with other people and listen and realize there is another dimension, that you can’t just throw out some recommendations and say they have to happen.

- The problem we have as an agency, and this is serious, is this division of labour, with the managers doing the management and the scientists doing the science, and there is a real lack of overlap. There’s a level of mistrust between them and lot of managers especially at the operational level don’t have degrees, they don’t understand the science, and that’s not their thing. They just want to do, just tell them what to do, and they’ll do it really well. Some of them get more engaged and into strategic stuff.

**2.4.3 Public vs private interests**

- A feature of adaptive institutional arrangements is nested redundant institutions – how do you integrate the interests of all these agencies and users in the decision-making processes for an area? Well it’s very difficult. The biggest difficulty I see is that government agencies’ obligations are to protect the public interest, and that goes beyond the interests of people of Ningaloo to people who live in the state, the country and the world. The problem with a lot of those local groups is their interests relate to private interests. You do need them at the table; we have management advisory committees and they have a seat at the table, along with everyone else. So DEC and the other agencies are the keepers of the public interest, and a subset of this is the private interest, so you balance the competing public and private interests through that committee process. That’s specifically for the marine parks.

**2.5 Political issues**

- Another issue would be if the models are very good and do their job right, but produce a result that the political arm of Government doesn’t like, how accessible will the models then be to the community? That access will always be subject to political will.

- Maybe the model is no longer useful after five years, but if the shires etc. having been using it during that time, and built their understanding of the complex system, would it be a dead end? There was an unspoken reaction in an executive meeting about the MSE model when the scenario of a road through from Gnaraloo to Coral Bay was posed. It was: the scenarios aren’t really that relevant because the things that will drive the outcome of that decision can’t be fitted into the modelling framework. The decision will be more about regional benefits, National Party-Liberal Party coalition tensions, etc. How do you model that? It doesn’t mean we shouldn’t use the model, but it’s the reality and it might give some direction about how else to use the model, e.g. if that decision is made, then maybe we could use the MSE to highlight the management strategies we can use to minimise the impacts.
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- Four years on, when review of the management plan comes up, this information will be very valuable. But right now the decisions being made will happen according to what people want, not necessarily according to strategic planning.

- So WAMSI also finds itself at the end of a process where the political climate isn’t necessarily there anymore. The interest is not there. There is confusion about our role as an agency, which is fuelled by the attitude of “let’s not be held up by these do-gooders, we’ve got to do, we’ve got get the economy pumping and give the community what they want.” That’s where we are at the moment. Knowledge is not going to be something that is a tradable commodity at this time – that’s my feeling – in the regions. The Perth base might be different, because it’s run effectively by liberals. In the regions, we just had defection of a minister to the National Party. He’s clearly picking up the vibe very strongly that the people like it, and I’m picking it up to. Attitudes towards the agency – people are now empowered. These people aren’t the thinkers, they’re the doers, let’s just get down and do it and not worry about all that fancy stuff. We can’t see global warming so let's not do anything about it. That kind of thinking is now predominating. We need heavy industry, jobs, etc. I think that’s where we’re heading, so this kind of work was created in a certain climate, and we’re now shifting into a different political climate.

- The real issues [that the model can address] are not what the ordinary man on the ground dreams or visions for the Ningaloo coast, it’s what the State Government, and the political arms of it, visions for the coast. Because that’s the way it’s going to be, model or no model. Case in point is the new boat ramp in Coral Bay. What modelling or EIA or consultation was done prior to it? It wasn’t there the one day and then it was there the next. There were significant marine pollution issues during construction. It’s all just whitewashed because it’s a certain politician’s pet project. These are the greatest type of challenges on the Ningaloo coast, ill considered upgrades and developments by or for Government that is just goes up without due prior consideration and always without credible, transparent or any (!!) prior environmental impact assessment or strategic impact assessment. And so, whether there’s a model or not, it really depends on current political intention and will, whether they want hotel developments on the reef. And that’s where the disillusionment with process sets in for the ordinary man. He goes, ‘So much of our time, energy and emotion goes into participating and working on the models, but when it really matters, our views and input are squashed’.

2.6 Lack of Imperative/urgency

- When there are political social or economic imperatives at work, knowledge transfer happens very rapidly, no problem (that’s the hawk in the flock). But when those imperatives are absent, then it’s a very stymied process. Because we’re not dealing with massively degraded places, there’s no crisis. It’s possible that no one will use the research because there’s no imperative to use it. The status quo is inertia, we’ll keep doing what we’ve always done because nothing is wrong, why change? It’s a waste of time. The flocks move in a coherent but chaotic pattern, when there is no external driver (e.g. a hawk).

- Unlike fisheries management which is largely reactionary, most biodiversity conversation research is proactive. So most of the Ningaloo Research Program falls into what we’d call the proactive knowledge transfer basket, rather than the reactive knowledge transfer basket. There’s no urgency, so it’s hard to get the practice change. Which is why we’ve come up with this framework - we have to put energy into improving communication pathways, we have to get the people sitting down and talking and recognising that there are reasons to use this information now and to make changes for the future.

- Fisheries issues tend to be more reactive, so they don’t have a problem transferring the knowledge because the people and the agency want it. Whereas some people would have the view that we could still manage Ningaloo without the 30 million dollars spent on research, because there’s no burning issue that needs to be resolved. We don’t have a constituency out there saying: if you get your policy prescriptions wrong, you’ll not only affect the resource but whole local economies (e.g. in the case of Rock Lobster). There will be impacts if we get our policy wrong, but it will be over long time periods, so there’s no urgency.
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Here at Ningaloo or at worse the Kimberley, these are remote pristine wilderness areas with one person per 10sqkm, you can’t generate the imperative/urgency to generate the funding to support these sorts of structures, so we have to go to something must simpler. We can’t get 10 million dollars to set this thing up for Ningaloo and run it for the next five years. That’s a real problem. People think things aren’t that complicated up there, a few oil producers a bit of fishing, we don’t need a model to do planning. And at this point they’re right, but maybe in 15 years time they’ll say, oh I wish we had done it a bit better.
Opportunities for research uptake

1 Using the research

1.1 Informing management

1.1.1 Managing tourism/visitors

- It would be a shame to have all this information sit there for 10 years, with all this tourism development taking place, then not coming back to the data until something bad happens.

- [Using the models, you can, for example, see how many different types of visitors you'll get if you add a 500 five star beds or you add 500 caravan sites to town, and look at where they're likely to go or what they're likely to do. Would that interest you?] 4 and 5 star people are more likely to jump on a whale shark cruise whereas your caravaners are more likely to visit the beach access, use the car parks and fish off the beach, so yes.

- One thing that I have always struggled with when it comes to research and surveys, is that their results always tend to show many more people come here to look at stuff than do fishing and things. But you go down to a caravan park and every second bay's got a boat and fishing lines. It just amazes me that the surveys show, I can't remember what the figures were, but the figures show that people come here to snorkel and to look. This is different from what I actually see, which is fishing.

- Visitor activities may change with time. I guess you're going to get more people, but less people on the fishing side of things. It was always coming up with the Jurabi-Bundegi coastal park committee, because the DEC people would be throwing it at you while you said, 'No, because if we close that track we know we're going to have a queue a mile long of fisho's waiting to access another track. Why has your data missed all these people?' If the data is 100% correct, if there is a big swing that way, then I guess that affects what we do with any future infrastructure works on the west coast - do we cater for fisho's or are we catering for wildlife experiences.

- I'm thinking about the model with respect to the Jurabi coast because it's an important rookery and they've got the turtle interp centre there. It sounds like it has good information for the commercial sector to see where they can target their market and what's going to give them the best bang for the buck. From the Shire's point of view it would be a case of what market is going to cause us less drama with infrastructure demands. But they're going to have to meet in the middle. If the commercial sector gets a better bang for their buck on one demographic and it's the same demographic that the Shire has to do the least for, then everyone's happy. But if it ain't the same, you're going to get the Shire wanting to zone users or controlled users one way and it's going to upset the tourism industry or something. But it could provide discussion - e.g. if tourism is going to make this money but it will cost the Shire, then someone might need to pay levies or something so it doesn't impact the general rate base.

- When I look at research on tourism, it is more important to find out why people aren't coming. does the sort of research looking at why you come up here—swimming, fishing and snorkelling, etc. But I want to find out why people aren't coming. And most of that reason would be 'I don't want to lie on the beach
and there’s nothing else to do besides...’ So that’s how you factor in what other sort of activities to put in, a kid’s activity – like the trampoline and the mini-golf and the fun balloon...And why aren’t people accommodating on the coast, because it’s camping. So what accommodation needs to be done. It’s almost like saying, what could be here, in a tourism sense. I’d rather do focus groups in Perth, if I was in our research department. I’d say ‘let’s talk to a hundred people in 10 different focus groups that haven’t been here, but have heard about it and haven’t come.’

Say 100,000 people come, I would say, there are almost 60,000 who come every year. If you look at your internationals, they’re pretty much your ‘one-offs’. And your eastern staters, probably 50% of them are one-off. But the majority are the domestic west Australian market and they are repeat visitors.

I see the Tourism Futures model used in the future for answering specific management questions for user groups like the shires and DEC and WAPC (NSDO) (e.g. doing model runs to answer specific questions they provide us).

Ultimately with most of the stuff that we’re looking at in the park, the underlying driving factor is visitation and usage. We are getting more and more people coming so it’s something that definitely we need to factor in.

### 1.1.2 Managing Parks

#### 1.1.2.1 General

- Info, info and info. We rely on it and we need it. We can see what is happening out there and we see the physical impacts. But it’s the planning for the future this will help with, I hope. I’ve never done this sort of stuff before. On the ground, business, yeah, but this whole model, to me it’s new. And maybe the stuff where we battle with, with managing, let’s face it, we manage people. Maybe those questions can’t be answered by the model, I don’t know.

- Primarily our driving factor is the Ningaloo Management Plan; the draft of the Cape Range Management Plan has just been released too. So those are primarily the things that are driving our management requirements in terms of priority things that we would like to look at. But there may be opportunistic things, if someone comes up and says, ‘Look, I’m doing a study on octopus’ and you know, octopus isn’t mentioned in the management plans but you think, you know what, that would be really useful to get an understanding of where octopus live, what’s good for its habitat.

- I don’t have the background to be able to say, ‘well yeah, I know this and this and this has happened and I’d really like to know a, b, c, d, e.’ So I pretty much have given you the impressions and the experiences that I have had to deal with. There’s some fantastic stuff going on out there and even just for staff information, letting staff know this is what they’re finding out there or this work’s been done and this is what they’ve found, so we’re going to change how we do a, b, c, d. I really think anything that results in increased dialogue has just got to be beneficial.

#### 1.1.2.2 Revising marine park management plan

- I’m excited about the rewriting of the management plan, because it will work with that material and hopefully get resourced sufficiently and we’re going to have a ball in terms of being able to model it and throw a lot of stuff into it. And hopefully they’ll have enough understanding of the complexities of all the interactions, not just the isolation of a few factors, to make it work AND palatable. That’s always the big one: we cop a lot more when people aren’t happy with the outcome, even though rationale science might have developed a good argument: the emotional connection is not satisfied. People just don’t want to hear some of the things research is producing, and now a days you can choose.

- There is potential for our herbivory research to be used, but I don’t know whether there are any set plans to actually make use of the information we will provide. The research could be used for modification of the marine park management plan. When our project ends in 2010-11, etc. will make all the information available in a format useful for management, but whether management is actually going to take action, I don’t know. I don’t know whether there are any actual plans to incorporate the results from all the research into a new marine park management plan.
1.1.2.3 Carrying Capacity of Park

I think one of the concerns for me and concerns for people in the Cape Conservation Group and also the Coral Coast Parks Advisory Committee is just what is the carrying capacity of the Park? How many people can it take? Because there are plans to expand the Park, there are also plans to put these eco-nodes in, and that’s always a big concern. If you’ve got a node - they wanted to put one somewhere in the range on the other side close to Oyster Stacks - a 100 bed eco lodge, and then you add the staff working there, how are they going to deal with the sewerage? My immediate concern was, well, Oyster Stacks is already an area that really concerns me in terms of snorkelling, because I’ve been on DEC’s back for years and I think it’s because I’ve been going hassling them that they’ve finally got signs up and they’re actually going to put some sort of a floating gauge that says ‘you really shouldn’t be snorkelling now’ because the tide’s too low. And I said, well, if people are going to run tours from a lodge that’s close to Oyster Stacks, where do you think they’re going to go? To Oyster Stacks or Oyster Stacks? And one of my concerns now is they’ve now made the parking at Oyster Stacks and the accessibility to getting into the water at Oyster Stacks so much better, so what’s happened? Now it’s becoming like Turquoise Bay. Friends and I went there the other day, one Saturday, to go snorkelling and we just took one look and we left because (a) there wasn’t any parking, and (b) it’s just been used to capacity. I don’t know when their floating gauge is going in...there’s going to be like a gauge with a floating marker that shows it’s low tide, you really shouldn’t be snorkelling now.

I think any model, even with its limitations, that says, well look, really, with all the work that we’ve done, this is the carrying capacity for the park. So you can’t go putting in 100 bed eco lodges and that sort of thing, or you should only have a maximum number of camping sites, because they obviously want to increase the number of camping sites in the Park. So I personally think from, with my background and limited knowledge of models, if they can come up with a model that deals with those sorts of things, I think it would be fantastic.

1.1.2.4 Sanctuary zones

At the Symposium they had a lot of stuff on fishing, and I would imagine that information would get fed back to Fisheries who would use it with DEC about where to put sanctuary zones. Some do question whether the sanctuary zones are working.

I was talking to a Fisheries research guy a couple of weeks ago and he said you might have a sanctuary zone and that’s great, but they’ve got evidence from research that fish congregate for spawning for 2-3 months of the year, in this spot which is outside the sanctuary zone, and boaties are all clued up on the when and how. Well, what ramifications is that having on the species up and down Shark Bay and Exmouth? If there’s no research out there, that’s how you plug the gap of ‘we need to find out’ because Fisheries are saying that maybe we need to make a sanctuary zone for 3 months of the year – which has more protection of a species than a sanctuary zone dedicated 12 months of the year. The fish congregate, the fishermen congregate, and hammer right at that time, hammer it.

The bigger picture stuff – i.e. the review of the marine park management plan in five years – involves taking a whole lot of research and applying it to a regional/larger scale in terms of sanctuary zone placement etc. As a day to day operation agency, that isn’t really our job – it gets done down in Perth. In future we’ll be rezoning, we’ll be involved in the public consultation. There’ll probably be a planning officer on it – so the research will feed into that scale. It will provide some arguments against people critical of the sanctuary zones. For instance some of the work being done by [redacted] shows the sanctuary zones are working, we’re getting more snapper in some sanctuary zones, etc. It’s a bit of knowledge you can give to people who have criticisms about the sanctuary zones.

Knowledge is a good thing, but when you get into arguments and you waver and don’t take a solid stance on something you’ll get undermined. From a purely objective scientific perspective you start to put all your weight on a few things that may actually be fairly brittle. Then you start to attach your own personality and your own success and no one likes failure, especially driven people. Then you ride it to the bitter end, even though it’s become clear you’re flogging a dead horse. When battling out the extremes – like sanctuary zones, if you start moving away from your moral high ground and give a little bit, the forces
around you they’ll rip away everything else and you’ll not end up with a little adjustment, you’ll end up with a huge swing. And that’s the nature of it. Knowledge is good, the more you have right out front the better place you’ll start from.

1.1.2.5 Facilities/services

- The other thing that's in the pipeline at the moment is this, what they’re calling a Super Camp at Milyering which will involve developing a new big parking area/camping area to allow more people to stay. What effects is that going to have on the surrounding areas? At the moment the park’s full and has been full every day for pretty well the last few months. If we then start adding more people to the equation, how is that going to…? Well, obviously Turquoise Bay is going to be a prime one, but what about road kill, area degradation, people wanting to get out and have their own little wilderness experience, all those broader factor thing. So we’ve probably got a number of different scenarios that we could look at that that model would probably be helpful for.

- When DEC wants to put in 200 bed campground - basically it’s a caravan park really - in the middle of the National Park, that’s got huge consequences. If they try and cater for the demand, they would put a 1000 bed campground in there and they still wouldn’t keep up with demand. The key question is how many people would the current level of amenities in the park support? Are they going to have cues of cars driving back from Yardie Creek every night and knocking off kangaroos and other wildlife by the dozens? They’ll be increasing the accommodation capacity of the Park in response to the increase in demand but without really increasing the amenities, the facilities, you know. There’a are potentially huge consequences for the environment, park management and resource allocation by DEC.

- It comes down to having access to the research when we are doing, for instance, our works program for this year. As an example, I’ll use the risk management. We get allocated x amount of dollars per year for upgrading or maintenance of our campsites. They keep getting wrecked, cars hit bollards and whatever. We just keep fixing stuff, it’s Groundhog Day. But is that actually managing? Potentially it is, but maybe it’s not. Is there better ways of doing it? That’s where I’d like to get that research and information. Let’s face it, on the ground is what happens, regardless of what we like to think is happening, the people out there they’re making an impact. If we talk to the research crew and say, ‘what have you discovered’ based on all your surveys’, then we can start working, we have to start working together. Impacts on the marine environment, we have developed Oyster Stacks, a proper road going in and a bit of a welcoming type node. Before, half a dozen cars a day. Now a hundred cars a day. What have we done? This is where the planning stuff is critical. Ok, it can be closed, but it’s planning for the future which is so important.

- We talked about this with Lakeside, it’s great, but what’s the impact of 50 new campsites, up to 150 more people each day for 6/7 months of the year? What’s that going to do? Some might say it probably does have an impact but it’s a sacrificial area so people get that experience. Do they? Is it a good experience? Is it what they’ve expected? So people have gone there, but maybe they didn’t get the experience, they went, let’s go to Turquoise Bay, or go I’m going to go and find my own place. Maybe that’s what it’s all about, going and finding your own place. We’ve got x amount of roads and tracks going in. That’s where the research will be so handy, to look at or discuss further. This is what we’re planning. Is this good with regard to the coral communities and the currents?

- So people can see that decisions we as a Department make are based on this research; no, we’re not going to provide any more toilets, any more camping grounds in the park. But then we can say the reason we’re not is because if we do that, the research and the models say this is potentially what could happen. Is that what you want? Well, no, we don’t. Ok, great, well that’s our decision if you support it.

- Can the models look at waste management stuff, because that’s another thing we’re looking at. For example, we’ve just picked up a rubbish truck but it’s all an expense, so do we pull the bins out of the park? We have the same question for the Jurabi coastal parks, should we pull them out? It works elsewhere but will it work here or is there that culture of just throw it out. From different areas that we have pulled bins out it show they haven’t. Like Turquoise Bay, there’s no camping, it’s a day site, you go there, there’s no bins but it’s clean, it’s great. But in certain areas it won’t happen.
Yes. It'll be interesting. I'm into that sort of modelling, you know, if it gives you answers – well, not so much answers – but it gives you stuff to think about. Because we base a lot of our decisions on observations but are they the right decisions, being based on people’s habits and historical use patterns? Just because people expected rubbish to be collected for the last 10/20 years, does that mean we have to necessarily continue it?

Another example is the oceanography study, showing how corals take up nutrients when the water flushes across, and how the general oceanographic autotrophic food chain happens with filtering and uptake. It's exciting because it's a perfect experiment. We now know more about where the currents are going and how they work. Now I'm interested in using that information in modelling for people. So how strong will the currents be at Turquoise Bay? Can we use this research as a preventative tool, as easily accessible surrogates, such as wind, tide and swell, etc., set up in a way that sends a daily indicator to telling me if I've got a problem with currents in Turquoise Bay today. A nice complex formula is good, but is it cost and time effective for staff to sit down every day and work through it – no. So can surrogates be used, can a formula be set up that can run daily to tell us what's happening with the currents, so the visitor centre can put up a little flag, like we do with fire. Some of that has already been discussed, but that sort of work takes secondary preference to the bigger picture stuff. People seem more interested in the bigger picture stuff.

Information about currents would also be very useful for designing snorkel trails, etc., to know where drifts and currents are. I've asked researchers for this information, but no one has got back to me. Not sure why, I thought we had a good rapport; they may be too busy, or may not understand where I'm coming from. But I need to know safe launching pads, and where we should put recreation sites to minimize snorkelers getting washed out to sea.

[With respect to questions for the models] it is becoming more and more evident that mooring management is something that we need to deal with. An example is they're planning on having an international fishing tournament; potentially we're not going to be able to cope with that extra visitation. If we say to people, 'yes, we're going to put an extra 15 moorings in there,' what sort of impact is that going to have. And even the areas, like at the Bundegi boat ramp, one of the boating channels actually comes in right through the swimming area. So do we look at moving the channel, sacrificing some area, to make it easier for everyone? What are the implications if we do that, what are the implications if we leave it?

I'll need to know, for Bundegi and Tantabiddi, the bathymetry of the area for some of the moorings.

1.1.3 Managing coastal strip

1.1.3.1 General

We need to reduce or minimise coastal tracks to protect coast vegetation and prevent erosion of the dunes. We need to somehow increase ways of controlling people’s access without spoiling people’s enjoyment – we need a good balance on the coast. Along the Ningaloo coast we should promote wilderness camping (caravans, tents). Development, if any, should be very low key; maybe just a few environmentally friendly dunnies. Research is critical to ongoing management of the coastline. The coastline needs to be protected, whether the pastoralists manage it or not.

I was surprised at how valuable and applicable the research presented at the Ningaloo Research Symposium in Exmouth was to the day-to-day issues we face. This area presents a myriad of issues every day, and the research that was presented helps with prioritising. We then create resourcing and work plans for the priority issues. For example, I have a long list of say 100 environmental, social or education issues that need attention. When you put a priority filter over these issues based on the recent research findings, out of the 100 you identify the top 2 or 3 issues to focus resources and work on. From this, we determine the next year’s priorities for the business, where we allocate resources to and what we address. And I found that surprisingly valuable.

The landholders / managers are the people in the trenches dealing with onground issues, physically, practically, the whole day every day, over and over. If they are well resourced and know what's going on, if they have the relevant information from research efforts, it equips them so much better to deal with the
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public and to feed that information through to them. Most of the public really do have the environment at heart and want to see the right thing done, but there’s an educational component that is sorely lacking. They won’t believe in the marine sanctuary zones or whatever the issue is until they understand what the sanctuary zones achieve. None of the information presented at the Symposium is in the public’s mind and that is a shame because if you can get the information into their heads, they will police their own behaviour. The best way is for landholders, managers and business owners to understand these issues, who will then disseminate it down to site managers so they understand it and feed it to visitors and the public. But there’s this whole vacuum where we haven’t been able to get the research findings down to grassroots level.

1.1.3.2 Visitor experiences and preferences

- The research is quite broad though, isn’t it? So what I look at and what I’m interested in as far as research is: people have come here for years due to various reasons, warmer weather, remoteness, etc. Then we’ve got the Ningaloo Coast Strategy which makes x amount of recommendations for tourism nodes etc. with bed limits and all those sort of things. Cape Range, it sorts itself out, it’s a park with defined camping areas and sites and the people that come here, they love that experience, they love that set up, they like the style of those camping facilities, it’s quite handy for them, it’s quite close to the town site of Exmouth, so they can get their food, water, all that sort of thing. Yet for them they feel they are still having a remote experience. On the other hand, if you look south of Cape Range National Park, we’re talking stations all managed by the pastoralists. I want to know what makes their visitors want that experience, one without toilets, without water facilities, without a defined area, let’s call it remote. I think I know the answers because I’ve come here for many years myself, families traditionally have come here.

- So if the state was to say we are going to have DEC manage this 500 metre strip/2 kilometre coastal strip, whatever the boundary is, what is it that you could do to not so much enhance but retain the experience that people are coming there for, yet manage it better? There are major issues down there such as waste management, both paper and human waste. That’s that camping visitor experience stuff that I’m interested in.

- Anyone could probably use bits of my thesis for their aims. I guess it’s like consumer insight information that I’m generating. It’s an insight into how the coast users feel, so that’s quite useful information to anyone involved in this area – how their users feel about the services they’re providing. I’m looking at broader literature and how does Ningaloo sit in it – it’s not about how best to run things here.

1.1.3.3 Campsite locations

- Are the campsites in the best locations? Look at 14 Mile at Warroora Station as an example, its coastal camping at its purest, right on the beach. However there are risks involved there such as large swells, king tides, all joining together at certain points which would erode that beach, and caravans and vehicles could end up in the water. I don’t know if the models can look at all this sort of stuff from a visitor risk management perspective. If you retain those areas for people to camp in, is it a good thing? Is it an acceptable risk? Ok, tsunamis, they’re rare events and if that was to happen, well, geez, even if you were behind a sand dune you’d still be stuffed.

- Is it an acceptable place to have these campers given the knowledge that we do have regarding the swells, the tides etc. Is that acceptable as a liability issue from a government perspective. So that’s one type of information that I would really like. Are these areas in the best locations – yes, people have gone there because it was a great fishing spot, it was protected from the wind, etc. If you were to move those sites to a different location or a harder location that can sustain that sort of impact with caravans etc., would the people still come? Would they still feel that they’re getting that experience? Because obviously a lot of people have been coming up here for 20 years/30 years even. Generation after generation.

- This [Nine Mile Camp] is an example for the whole coast: whether it’s managed by the state or whoever, are these camps in the right area? – if they’re not and we relocate them, what will the impacts be? We’ve seen firsthand that it’s not a good situation, like at Nine Mile. I’ve camped there for years as a kid… I stand back now, being educated on environmental issues, and I say, of course, it’s way better to be up here (Higher and more stable ground). It has better views but for some reason historically they do not want to
shift from the dunes. I think it’s a matter of ‘I can just walk to the beach’ even though it’s only a difference of an extra 100 metres. So there’s this whole historical convenience issue. It’d be interesting to find out how you tackle that. This is the classic scenario which operationally and on the ground as managers you struggle with.

- The models should also make recommendations, if that’s possible. What would the recommendation be based on, a range of different factors? For example, do we remove these campsites from here and replace them or put them up on higher ground? This kind of information is critical if the state were or DEC take over the coastal strip. Also, if we’re developing coastal camping nodes, what’s the maximum number of campsites that should be in one particular node? For instance, in the park, we have anywhere from 5 to 12 or 13. We’re about to embark on the super camp at Kori Bay at Milyering, which may have up to 50 sites, really big. It’s going ahead, we think it might be. It’s going to help us. It’s actually going to get people into the park who can’t now because its full.

1.1.3.4 Infrastructure/facilities

- In particular if the state was to say DEC are to be the managing body for the rest of the coastal strip. By geez, we would have to be very careful. What has the research said? Based on that research, what’s the best way of tackling management? How much money is basically required to do this sort of stuff, i.e. waste management? Do we want infrastructure, do the people want the toilets or are they happy with chemical toilets, so we now need to provide proper chemical drop-off points? Getting that info is critical. So yes, the research and modelling would certainly be used…

- With respect to the day to day management decisions we have to make within a broader management framework, there’s still a bit wanting, although a number of projects have those components within them (e.g. access to beaches and work done on stabilization of foredune areas, the hyperspectral analysis). I’m quite aware of all this because I’ve been going to the Ningaloo Symposium for the last two years, and often the research leaders and program leaders have come and seen me. They’re looking at the stability of areas, access tracks, how access tracks might interrelate with vegetation, the landform, sedimentology, geomorphology. For us, we’re now looking at rationalizing tracks in a pragmatic way: we see people want to access an area, how they get through, where’s the best way. This is done by experienced people going out on the ground, and often saying “well there’s a preformed track, we’ll use that.” Ideally, the geomorphology information from the hyperspectral data analysis would be available to us to use.

1.1.4 Determining infrastructure and service demand

1.1.4.1 General

- I do recall saying that a lot of the work that’s done would be designed so it could be used by the local government, particularly in relation to showing the gaps in funding local government services because of the influx of tourism that we get, here, where the permanent population is 2,000. They were saying our model should be able to demonstrate that if we increase tourism by this much, the demand on local government is going to be this much. We should be able to use these results to go back to the Grants Commission and say, well hang on a minute, you know, your basing your funding on this when really we’ve got to deliver this.

- We’re looking for data that shows the demands on Exmouth as a tourism town. There’s the expectation that there’s going to be fish cleaning stations and toilet blocks and rubbish bins in car parks in remote areas, but they’ve all got to be serviced. Rates are very limited, so the main form of funding that Shire’s get are grant commission funding. There just seems to be a big gap, because there’s a lack of normal standard grant commission funding. It’s quite horrific what we spend on servicing those remote facilities for a town is with such a limited rate base.

- We would be interested in knowing whether the models/survey work can deal with what services there are on the coast in the way of rubbish bins and if they weren’t there how would that affect the visitor interaction with the area. If there’s no rubbish bin there does that upset someone enough that they’re not going to come back to Exmouth?
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- Certainly running that model to look at different types of clients and what activities they do could help us know what infrastructure demand might be in the future. For example, next to the Lighthouse Caravan Park there’s another slab of land that is zoned tourism; there’s been a lot of debate on what that should be used for. You could use the model to peg down what knock-on effect that’s going to have. That could help us understand what’s better really for the environment as well as our operations, whether it should be higher order ecotourism or a caravan park.

- Coral Bay is blown out in terms of visitors – the facilities can’t cope with the numbers, and the place seems overcrowded in the tourist season. Rather than expanding into something huge, it needs to be planned out better to accommodate the visitors – we’re a little short on facilities.

1.1.4.2 Road works
- I’m interested in how road maintenance fits into the whole model. With coastal camping there are some knock-on effects. If it’s allowed to continue or if it’s allowed to grow then there’s some sort of maintenance required on these access roads because they become dangerous. If they’re gazetted roads the Shire’s responsible for them, but there is only a limited bucket of money that’s provided by the state for maintenance. I think they have a regional road group and they sort of work out what roads are priorities and what money goes where.

- With the Shire, they could do a ‘what if’ with the model on the cars up the road and back their funding for roadworks.

1.1.4.3 Water
- Then there’s the water. Is there enough water in town? Hydrology is way out of my field so I’ll leave that to those who know what they’re talking about.

- Groundwater information is of great significance to the community, particularly reduction of the water tables in the region and effects that’s having in the biodiversity of the reef. How this information is distributed would need to be defined, but certainly the key players and that would be the State Government, Water Authority, the local Shire, and the Chamber of Commerce.

11.5 Managing fisheries and the reef
- Have you looked at the rock lobster information that came out? It’s anecdotal, probably; if you see it as a researcher it would be like, well, that’s terrible. But what an example that is to the rest of the state? With everything that the western rock lobster fishing industry is going through right now, they could learn from research. Fisheries have made their west coast bioregion decision on that Kalbarri to Augusta area, but they’ve not made any changes to fishing north of Kalbarri. What’s going to happen to the fish stocks here? The research is there to show what happens around a no-fish zone and I can’t think who did who that fish researcher was at the presentation. Really the ramifications of their decision is there’s going to be more fishing up here if they don’t take action on this.

- My research on herbivory should be useful to managers. The ecological process of herbivory is very important to the health of the reef because it keeps algal biomass low. In the absence of herbivores, macroalgae can outcompete and overgrow coral, changing the entire ecosystem. Herbivores are thus crucially important in maintaining the resilience of coral reefs. We are quantifying herbivory at multiple spatial scales. We’ll find out what species of fish are more important in terms of consuming algae, and we are quantifying how much algae these species are capable of removing.

- We’ll be able to identify who are the key species to protect in relation to herbivory, to ensure the species that consume algae aren’t being taken out of the system by human actions. In contrast to what happens in other parts of the world; in Ningaloo there’s no fishing of herbivores per se. However, there is some evidence that suggests that removing certain predators can have some indirect effects on herbivores. Structural complexity also affects herbivores, so modifying structural complexity will impact fish populations (e.g. if people were to start anchoring on the reef and that wasn’t regulated, and if the number of tourists increased hugely, it would eventually have an impact on the structural complexity of the system).
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- I suppose from a Departmental (Fisheries) point of view, the research is a large consideration, along with policy and compliance, in how we deliver our business. So seeing the fish-related research go back to our Department for consideration when it comes to management is all I would really want from my end, and I’m assuming it will.

- Obviously if there’s something that needs attention now, from a fisheries compliance point of view, if something’s been identified by the research as a real risk, and we can somehow develop a compliance strategy around that, that would be very handy.

- If the models can give us an idea of where they believe much of the fishing pressure is going to be [based on current trends in the region], that would definitely help. From a compliance point of view, we’re interested in any sort of information that we can get hold of that will allow us to direct our resources into a bottleneck, rather than us just floating around the sea trying to cover all the areas.

- Certainly research looking at the movement of fish through the Marine Park, which species are on the move and which remain territorial, would be huge for us. For example, my understanding is that coral trout are territorial and stay in the same area, whereas tusk fish and the baldchin groper move throughout the reef.

- If we know there’s certain areas where people en masse go to catch fish while they’re spawning, that allows us to go to those areas, so we can target people who get themselves into position where there’s so much fish that it’s one after the other. If we can get an idea of where those fish are going to be, where the people have found out about spawning areas or areas where there’s a lot of coral trout, that would help us immensely.

- I’ve done a run up and down the coast and met all of the station owners and spoken to them about what their issues are and the ways we can police the areas better, and they have actually mentioned to me that they’ve seen people at what they believe are spawning grounds and haven’t been able to help themselves. That for us would be of huge value.

- Another issue that we’ve got at the moment is a lot of people are targeting deep water finfish. They’re all fishing in 300 metres of water, in predominantly more commercial grounds. So any research on biodiversity of deepwater finfish would be handy. Rays and sharks are not really targeted as much as other areas around Australia due to the number of better fish to eat, so I don’t think that’s a real issue for us.

- We’re the guys on the ground who hear a lot of the anecdotal evidence about what people believe is happening out there with respect to fishing. If we add that to the mix as well as the research and this modelling [looking at different fishing regulations], and then you can certainly present a better argument. If the models are saying, well, if you reduce the bag limits down to half in this particular area, you would hope that would reduce the pressure on those fish.

- Certainly the belief of people that live here is that there’s a problem. Most of them have been here for a long time and they’ve seen the pressure increase and they’re probably not getting the fish they used to. Now they want to all do something about it. So I think there’s a push to reduce bag limits in this area. Again it comes down to political push, if enough people push the Minister and talk to him about certain things…Using the models to look at fish management - that comes down predominantly to policy, people within policy.

- I’m trying to police, invertebrates, fin fish, rays and sharks. I guess over the last three years they’ve developed baseline research, but is the research going to be ongoing if they can get the funding?

1.1.6 Informing politicians

- And that’s where the research is needed, for the real decision-makers. If you can say one hundred percent Minister, here is a factual research document, so when someone says nay, it’s full of rubbish, he can go ‘there it is’. And Fisheries sort of bluffed their way through that with this thing down south, because they don’t have the research information to show it. So then they’re propagating the whole ‘you’re only doing this because…’ whereas if you can get or you can show things categorically, like the rock lobster
industry, there it is. There’s the information. There is no ridiculous whatever, you need to make the decision and stand by it. [But no research is definitive. It cannot be 100%]. Yes. People will always want to shoot holes in something. But when you’ve got to have a decision made, well, it’s your choice Minister. I think the political stuff comes into play when you don’t have the research and can’t back it up. Then they’re going to go with the easiest option.

1.1.7 Developing sustainability indicators

- We should really use research to feed into triple bottom line approaches and sustainability indicators for visitor planning, and apply this research into detailed management frameworks and methodologies.
- We probably need a second round of research to look at sustainability indicators, based on what we now know about the reef.

1.2 Assessing development impacts and trade-offs

1.2.1 General

- I think if someone was putting in a development proposal together they’d be insane if they didn’t actually use the model.
- From the perspective of the Shires, the results of this study could be incorporated into environmental assessments to decide for or against certain developments, e.g. new boat ramps could indirectly lead to changes in herbivory via changes in reef structure caused by more anchoring.
- The models will show the range of behaviour you can expect given certain actions; they can help form people’s intuition about how this complex system might respond. In respects, the problems in Ningaloo are actually quite simple, as the environment itself dictates a relative narrow set of parameters for development. Thus, if managers and planners take a precautionary principle they have a good chance of getting development right here. It’s all about tourism development and what facilities they allow. Water availability, infrastructure, etc. create some fairly strict limits to what they can do sustainably.

- [Do you think the models would be useful to the ‘small man’ for looking at the impacts of proposed developments?] I think it would be valuable as long as the models are robust and produce results that’s within ballpark. The landholder / manager on the ground has a common sense understanding often backed up by years of site knowledge and experience of what that ballpark is, and if the model pitches it completely outside it, you’re going to have loss of faith in the model. But given the work that’s gone into the modelling, let’s say it gets the ballpark right, it would be valuable input especially for inappropriate proposed significant developments on the Ningaloo coast. The models could be used to demonstrate in a qualitative and quantitative way to Government why such proposals may not be responsible land use initiatives in the short, medium and long term.

- We would use the research as a group for things like submissions on referrals, or industry would use that information for potential impacts. So for example, the salt mine, I know of a researcher that was doing some research on the algae maps and the interactions between the algae mats in the Gulf and see, we would use that information as evidence of the potential destruction by a proposed salt mine.

- There’s so much going on. If there’s some research that could in any way back up something that someone’s trying to do or stop, because, any little bit of research that could go, well, ‘that isn’t a good idea if you did that’, would be great.

- As far as the modelling goes, I think you’re right, it’s going to be helpful if you can make the figures work for you. I was a little bit of a sceptic when I first talked to you, but it looks like it might come out fairly well and could be useful as long as the big problems are put into the mix as well. As far as private enterprise goes, I think there’s a couple of fairly big issues and I wonder whether the model can help or not.

- Oh, absolutely, I’m interested in whether the other industries (fishing, agriculture) are being factored into the model. At the end of the day, tourism doesn’t keep Exmouth and Carnarvon going on its own. If the townsite is closed down, well, we’re stuffed as well. We’ve got to have regional centres. That’s getting
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more strategic. Well, I guess the bigger the model and the more expertise behind it, the more weight it's going to carry, isn't it?

- The model will only interest me for major changes – like significant new development proposals.

1.2 Trade-offs

- [The other thing the models can do is look at if you do different management interventions, say, here’s a scenario you put a boat ramp in, here are your impacts. Then you can say, well what if we bring in education or what if we put in more sanctuary zones or what if we change the fishing regulations when we put this boat ramp in, then what are the impacts. So you can work backwards as well.] Will those models be able to address such wide parameters? It would be fantastic if it could.

- I use the MSE model to play out different scenarios people ask for, and come back to them to let them know if their objective was met or not, so they can get an appreciation for whether their management idea is going to work, whether there will be potential conflicts between different sectors or uses, or different feedbacks they hadn’t thought about that could eventually come to bite them in the butt. For instance, oil and gas to the north of Exmouth doesn’t look like it should clash with 10,000 more people in Coral Bay for the tourism world, but if there's a single water resource that is already limited and planning won't release more beds, you can either have houses for oil rig workers or hotels for tourists. There's an immediate conflict. So the MSE model can get trade-offs and potential conflicts out in the open so they have a common frame of reference and understand where each other are coming from. Then maybe they can find a compromise position that's semi win-win and not just a few winners and lots of losers.

- [How does the model determine what is sustainable?] The approach has been to look at a whole range of scenarios and parameter values and see if the assets are protected to a reasonable level. There's not going to be one right answer – there's going to be a range of trade-offs.

- That info has to get out to the public, showing that if you allow a five-star eco resort in the Ranges, or if you open up more campgrounds in town, etc., these are the impacts that will happen. Fish stock will be reduced by this much, so that means you will actually travel this far now for that rankin cod, which means your little 4.2 metre tinny isn't good enough, so you personally, Mr Local, will have to upgrade to a 5.5 metre vessel which is at a cost of $20-odd extra thousand dollars to you, and fuel and so on forth. Furthermore, this is going to happen, that’s going to happen. That’s on a tourist perspective. I suppose on the other side, gee, we’ve got what’s happening over in Onslow, 3,500 people will based there for the production plant. It’s just across the Gulf.

- But if they want to milk as much money as they can out of the place, and allow all development unless it can absolutely be proven to be detrimental, that’s where they’ll go wrong and cause environmental damage. Typically, the burden of proof argument is slanted in favour development because research rarely delivers a cut and dried answer. But this does not appear to be the case in Ningaloo - people seem willing to be conservative in their actions. The research will help people understand the tradeoffs that will come with allowing more tourism in the region.

1.2.3 Boat ramps

- I think the Coral Bay boating facility’s a good example where the research could be useful. The decision that gets made there, how does that impact on fish stocks.

- There’s so much information out there that the new Gascoyne Planning Committee could use. The different reef species and the deep sea environment, and all that stuff that I have no idea what they're talking about. But you’ve got to have it available. Like the Coral Bay boat ramp. What are the ramifications going to be and what are the long-term effects? If they’d looked at this research information, someone might have decided to put in a smaller facility, you know?

- I think [the modellers should run questions for] GDC, Shire and us, absolutely because there’s areas we’re talking with them about that need improving, roads, Tantabiddi boat ramp…we’ve done Bundegi and look at the impacts that’s having. So yeah, that would be good.
I’m worried about how many boats are getting launched at Coral Bay and the fish that are coming out of that boat launch. The boat numbers and size have increased since it was built. Some of the boats are that big that they’re even using trucks to tow them. What is that doing to Ningaloo fish stocks? I don’t know how you control the situation: reduce the number of boats?

1.2.4 Industry

We could introduce a module now where we can look at the impacts of the northwest oil and gas projects on the region in terms of first thinning out all the labour, because business’s access to cheap labour is probably going to exit, and secondly in terms of pressure of residential pressures, having more people being based here in the region. We can look at effects in terms of increasing tourists in the low season, and how that could impact on, say, turtles, for example.

Yeah, everyone seems to be worried about an oil spill, aren’t they? Interesting. I think we’ve got those prevailing winds that will help us out if there’s an oil spill.

So within the limitations of models, if models can answer those sorts of questions in terms of pressure from tourists and roads and any other possible stuff. Even if they can tie their messages in with models that BHP has done on oil spill stuff, because one of the things that I’m interested in now is with the oil spill up north, because they used to say to us, ‘An oil spill this size is a one in 100,000 chance of it happening’ and I’m going, yes, but that’s irrelevant if we happen to be that one year. It’s like saying to parents of a kid who gets a genetic disorder, one in 400,000 chance of getting it, and your kid’s got it — that’s meaningless, well, tough, my kid’s got it. If you get that oil spill. And then they say to us, ‘Oh, but you know, even if there is an oil spill, there’s no chance that we can’t contain it.’ It’s like there’s an example now. They can’t contain it, it’s spewing stuff out at 400 barrels a day, they reckon. Now if that was here, it would probably already be onshore — although the prevailing winds wouldn’t bring it onshore but you just need a north-westerly and it’s onshore.

And, ok, the mangroves at Mangrove Bay are very small compared with some of the huge stands further up north, but they’re obviously significant. So what impact then do they have? And if they can build models to show exactly how the currents are interacting, the Leeuwin and the Ningaloo Reef current plus the sea, what I’d like to see is the currents and how they’re interacting with the Gulf. One of the problems we have with the Straits Salt thing was they were saying, ‘If this happened in the Gulf it wouldn’t possibly affect the reef’ whereas said, ‘Well, how do you know that?’ He actually thinks there must be some mixing. So further research to make sure that we understand fully the currents and not only on Ningaloo Reef, but also how it interacts with the Gulf would be very, very important because you do have significant stands of arid zone mangroves in the Gulf and...

I think linking models, any models that are in existence, if they could be linked, would also be good. It may not be feasible but certainly if they could link in their models with the oil spill response models from the oil companies, I think that would also be very fruitful as well. Because, if you’re going to get an oil spill and it does bring it into Mangrove Bay and along the Reef and then the wind changes, how is it then going to be dispersed – can it then come into the Gulf and affect the mangroves in there? At the moment we just don’t know. Plus you’ve got the Muiron Islands as well which people tend to forget, because they’re sitting out there.

In addition to DEC and the Shire, I’m sure the oil and gas industry would actually have an interest in the modelling reports. Certainly the environmental managers for each of the oil and gas companies would be delighted to get their hands on the information. Even companies like Straits Resources and Chevron, because they’re working at a distance from here, would still probably show an interest. Where they’re creating their own models, maybe they could feed into model. And maybe work out a plan or strategy that says we’re going to work along this path, we’re going to have the least impact and our footprint’s going to be considerably less. Perhaps they can be compelled to be more environmentally and socially conscious than they’ve been before.

That’s what you’ve got to love research for, really, it pretty much calls a spade a spade. Halt the Salt is a perfect example. There’s not been a lot of research going there, and probably what research is drifting around in the ether because no one’s using it. The Chamber of Commerce really supported the salt mine
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going ahead and we didn’t, because we know there’s going to be impacts on whales, on their breeding
grounds. There’s a gap in the research, but if you had that research centre…

- That’s where I can kind of see that model would have been absolutely priceless. But there will be
situations like that again, I mean the Straits Salt stuff - imagine if you could put in to the model seven of
those big Panamax bulk carriers in the Exmouth Gulf a week, and look at the impact on X, Y and Z.
Straits is going, ‘Oh well now it’s not going to have an impact on this, that and the other,’ and then you
have researchers going, ‘Well actually it is.’ But again, I mean, your average person doesn’t have access
to all that research because it’s owned by private companies. So if you could get access to a model like
this you can hopefully somehow get some data and plug it in and see what it spits out.

1.2.5 Marina expansion

- It would be fantastic if someone could put the proposal to expand the marina in a model. One of our major
concerns is the impact of increased marine vessel traffic in the gulf on the humpback whales. The Centre
for Whale Research, they’re not researching this specifically but they’re taking photographs of whales,
have found that there’s a really high incidence of boat strike. And that’s with the level of usage that’s out
there now. So they want to expand the marina to bring in super yachts, cruise ships, service the oil and
gas industry, etc. What’s going to be the impact on the whales – threatened species at a vulnerable stage
of their life cycle, in critical habitat? They now know that they’re feeding down here as well. If DPI or Cape
Conservation Group had access to that information, we could say to them, ‘Hey if you increase the vessel
usage in that gulf by 10%, then your rate of disturbance/boat strike to whales is going to be X. Take that
to government and there’s no way that they’re going to let that happen! No way! So for the conservation
movement, that’s where the power in the model lies. But you’ve got to know it’s there, you’ve got to know
what it can do and you’ve got to be able to access it.

- God I wish this model was up and running 2 years ago. I’m just thinking about all our lists of concerns
about the marina expansion. We had about maybe 2 or 3 pages of concerns – everything from increasing
chemicals and fuel trucks on a road that’s already struggling with caravans and all the rest of it, what’s that
going to do to the incident of road accidents or road kill or…we just had a list as long your arm of concerns
about expanding the marina and all of that would be so good if you could whack it in the model and come
up with well, well, well, here you go. I don’t know what’s happened with it because it was the previous
government, but then I’ve heard that it’s all going ahead. However, having said that, they must have to do
some kind of environmental assessment before it goes ahead and I would hope that we would have
heard about that if that was happening.

- We’ve put out SOS’s to WWF and the CCWA, but they’re all under-resourced with funding cuts and it’s
just…it’s a desperate situation for the environment, I know. But maybe if we had access to a tool like the
model we could have put those figures out into the community, this is what the model says the impact is
going to be on motor vehicle accidents or chemical spills…’cause they’re going to put big massive fuel
storage tanks under the ground, right on the marina in a cyclone prone area. It’s just retarded! And I don’t
think people even visualise that there’s going to be big cranes in a major tourism precinct. What are they
thinking? And the other thing we kept asking them for, was like a visual of it. You can do amazing things
with photoshop, take a photograph of the marina, whack in your cranes and your fuel storage and your
loading bays and the area, put all of that down in a residential and prime tourism precinct and how good’s
that going to look? Do people at the Novotel want to look out their window and see loading bays full of
industrial stuff for the oil and gas industry? Yeah. I’m on my soap box now…

1.3 Informing policy and planning

1.3.1 General

- It is critical that all planners involved with outcomes along the Ningaloo coast are aware and well versed in
the models, have full access to them, and can use them for planning issues and decisions. If it’s too time
consuming and burdensome to consider and use the models from day-to-day, the models need to be
used for input into Ningaloo land use planning documents, including structure plans and regional plans.
(whatever’s a level up from the Town Planning Schemes). Get the scenarios and model predictions / outcomes out into the public arena with 6 months for consultation, not just one month. Go out into the field and consult using a knowledgeable person - it’s got to be someone who’s an absolute expert in this field, who can take the comments they receive and ensure these are considered and incorporated into appropriate land use planning documents before the final documents are formulated and put in place. This would be a very practical way of dealing with it, because once you’ve got the updated land use planning documents, including structure plans, regional plans and the Ningaloo Coastal Strategy etc, any town planner in any Ningaloo Shire would then simply interpret and apply those documents. Nobody has the time to run models every time they get an application in front of them and this type of application would result in piecemeal and fragmented outcomes that are not holistic.

- DEC, with their management plans in the Marine Park or Cape Range National Park, the Shires and their strategies, Gascoyne Development Commission, with their 5 year plans or 10 year plans, the Gascoyne Planning Committee – all those agencies should have a range of tools and the models should be one of them.

- The modelling needs to move fast enough, so that it can inform the review of the Ningaloo Coast Regional Strategy, or when reviews of these types of land use planning documents occur. The town planners who’s doing the day-to-day work are flooded and not coping with current workloads with the NSDO/NSDC work just coming online now. So if the research is ready, and if it’s not just about publication status, academic and PhD qualifications, if they actually want this work to mean something on the ground, we have to start thinking a little bit outside the square about traditionally held roles and responsibilities, and think ‘what do we do’ and ‘what influence or what pressures should be made to bear to make sure the modelling influences the planning process in real time’. And that way, if it’s a real consultation and not simply black box, then you’ll have the ordinary man on the ground, the landholders and managers possibly regaining some faith in process again. Because at the moment consultation and process is simply seen as stepping stones for achieving predetermined faits accomplis that were discussed and decided in Perth behind closed doors. Locked in and then people just get told how it is.

- I’m making a point of knowing the planning processes underway in the region and engaging with them as they happen for the duration of the project. We’re working with Tourism WA who are developing a tourism master plan for Exmouth; we’ll meet with them and do model runs for the master plan. This something we’ve done reasonably well in the region – people who run these planning processes know about the project, they know me, and they know the research that’s gone into it. They know they’ll be able to access the model and the data through me. We’ve got a degree of trust there that’s important.

- We’re also approached by people involved in planning processes. Yesterday I was contacted by a parliamentary researcher who was given my name by the Exmouth Shire for a submission into coastal camping and caravan parks in Western Australia. This it because the Shire told him he should talk to me.

- DEC, with their management plans in the Marine Park or Cape Range National Park, the Shires and their strategies, Gascoyne Development Commission, with their 5 year plans or 10 year plans, the Gascoyne Planning Committee – all those agencies should have a range of tools and the models should be one of them.

- Planning is about opening possibilities for the future, it’s not saying what’s going to happen. But, it’s good to make people realise what the consequences of those plans are, and the models can help with that. I’m talking about the Exmouth Structure Plan or Tourism Strategy. I think the modellers should be involved because otherwise what is the point of the whole thing, all these tools? We should be sending a message really clearly to the Shire that all this work has been put into it at no cost to them so why not use it, you know? The modelling tool will probably need to be adapted for that practical purpose but it’s already there more or less, it’s in near-final form.

- Yeah, there’s a whole heap of issues here, across the board? Gosh, we don’t even have recycling up here yet, it’s bad. I suppose getting all the research findings and the results is the only way that the government can make true planning decisions isn’t it really? But will they wait? Will they wait for all those findings to come out before they make their decision?
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- I was talking to someone about the project generally, saying CSIRO has put all this money into research in the area, and he said its kind of like they're trying to build a library of reports and documents and studies so that when it comes to future planning they can pull a book off the shelf that. At that time I kind of agreed, and said yeah, it was a good way to think of it. Maybe that's one way of thinking about research uptake or designing a body of research: as books on a library shelf. But they're publicly available documents and CSIRO's just simply adding to the knowledge of Ningaloo. But then it still relies on people knowing that the stuff is there and how do they find it and how do they use it and how they access it and all that.

- I would like to see the strategic stuff from the MSE model feed into DEC, the EPA, etc. Some strategic questions are in the form of guessing the questions people want answered and creating deep databases of pre-done runs that people can then query, but you’ve got to guess right, otherwise people will have to wait a week to get the answer.

1.3.2 Collaborative planning

- I see the Tourism Futures model used in the future as a collaborative tool where model results are used to inform a discussion about tourism planning in the region across a wide group of stakeholders, allowing them the opportunity to comment more broadly on the issue of regional development.

- There are a lot of projects aimed at research uptake here, including our project which looks at tourism and land use planning. stuff which will produce a great data set aimed at DEC, and model which involves putting all the research together into a management tool. There’s real attention to putting data into formats that can be used by managers and people on the ground, using tools to make the data more meaningful from a management perspective. These tools can facilitate collaboration and provide input into planning and management frameworks for the region. This potential for input is what gets people excited about the project. The question is how all these tools get taken up and how different groups can access them; access to the tool itself still has to be worked out.

1.3.3 Real consultation

- These planning document reviews are probably the best way of managing change and future land use. If there are research or modelling that could inform these reviews, let’s see a real inclusion of it, but make sure the draft changes / proposals are also sent out for consultation locally and state-wide. Do not release such important draft documents in a small one liner advertisement in the West Australian on Christmas Sunday for a week’s review opportunity!!

- Get these models involved in the planning review processes, ensure the model results are provided in the review documents, take them to the public broadly with lots of time for real consultation. Don’t just release the draft documents into a void. Contact and provide the draft documents directly to key stakeholder groups. I could come up with a list of key stakeholder groups on the Ningaloo coast in an hour. Part of the job is to go see these people face to face and say, ‘This is the document. You’ve got a real chance here to provide your opinion and we’ll include it. Send it back to us and we will include those comments’.

- [Who should do that?] That would need some consideration because where does that person come from? ... Someone neutral. And someone very professional, but not necessarily a slick consultant from Perth. Not a DEC officer. It would need careful consideration because, for example, you may think one of the researchers, but this may be a novel role to researchers / universities not normally executed by them that falls outside their usual experience and expertise. It’s difficult when it’s a planning official because there’s vested interest and conflict. Maybe someone from a university would be viewed as more neutral, but it would need to be someone with a clue about real consultation as well as communication. Because there’s researchers and there’s researchers. There’s researchers who will mix with ordinary people and there’s researchers who are quite arrogant and just stick with their own. The people that you’re dealing with are not stupid and it doesn’t take very long to see where allegiances and alliances lie. If the communicator(s) cannot be utterly professional as well as confidential, don’t send them out into the field. Do not send someone who has vested interests in the outcome or who is emotional with strong slants on how things should be in their opinion. It should be someone completely and utterly neutral. Otherwise, just the way
they look at you or their body language before they even open their mouth – you may see they’re
sceptical and resistant but really just trying to smooth you over.

1.3.4 Coastal Strategy Review

- More importantly for predictions about three future scenarios [ecotourism focus, intense tourism focus, industrial focus] for the region, consider inclusion of this as part of the review of the Ningaloo coast regional strategy, put it out in a draft document that’s released for public comment – and not only for a month’s review, allow at least 6 months for review and input by the community. Do this because the Ningaloo Reef environment can be so explosive - if you want something to work, don’t try and sneak it through! Do it in a way that involves real consultation. Give people those three scenarios and they can write in and say, ‘I really like Scenario B’. Don’t make it complicated, make it simple, you know ‘This is Scenario X, Y, Z; this model was used, these are the results. Which one do you like, drop us a postcard or whatever’. I’d like to see this done like a referendum. But even that is quite problematic because who gets to “vote” – is it the local community, is people that have an interest in the area, other people who visit the area including the internationals, is it WA or is it Australia because it’s a national asset?

- Importantly, the Ningaloo Coast Regional Strategy 2004 is coming up for review. We were told it would be some time this year, so it’s this year or next year. Could these models feed into the review? [Yes.] I know that different sectors of the community and Government including environmental agencies want changes to the Ningaloo Coast Regional Strategy. It’s very important that any proposed changes resulting from the consultation process are run through the modelling and that the model predictions / outcomes are made available to the public and to everyone to comment on before decision making. Surely that’s the whole point of the modelling: to inform decision making before we lock into options. The Regional Strategy is like the Bible. That is the way it plays out on the ground. The Government has said that the Regional Strategy is a flexible document and that it may change over time. If there is modelling, research findings or information available, its critical that it be considered and included during the review of the Regional Strategy. Even if it challenges outcomes that certain sectors of the community at the minute are committed and locked in to. That’s critical.

- I’ll be interested to see whether [نة’s model gives us an indication of what might happen with the Coastal Strategy developments.

- [Well, this is something that the models can help with – they could be part of a process where people look at the Coastal Strategy, run it in and say well what are the impacts going to be on fish stocks, corals, social factors, etc. It doesn’t give you the future but it gives you an idea what might happen.] Yeah. It’s just like making a cake with plain flour and wondering why it doesn’t rise because you haven’t put the self-raising flour in. You’ve got to have the mix right, don’t you?

1.3.5 Exmouth Structure Plan

- Even the Exmouth Structure Plan. I’m pretty sure I saw some research on the water, the Cape ecosystem. Now, the structural plan is looking how much development can happen, and what they’re all looking at is we’ve got water, we’ve got bore water, we provide water. But to me you should be saying ‘we need to make sure that people are putting in a recycled water treatment or desalination plan. What’s the effect of a detailed plan?’ But no one’s looking at these things. The planning consultant company doesn’t know what the research is unless someone tells them ‘this is the research, you should have a look at it.’ The structural plan is out for comment right now.

1.3.6 Gascoyne Planning Committee

- The Ningaloo Sustainable Development Committee should have been accessing a lot of this research information. But this is where that new Gascoyne body is replicating what they were doing. So the research still needs to be linked to them. You’ve got people coming up from Perth who are looking at, say, individual tourism development sites or DEC looking at parks. I’ve found that DEC use all their research but they’re never aware of where other researchers are. The Department of Transport use all their own research, they’re never aware of other research. What I do up and down the coast is put those people together because they don’t talk to each other.
1.3.7 Supporting National landscapes branding

- Of course if there’s Ningaloo, we’ll also have Shark Bay because their value is the same, there’s only going to be 2 National Landscapes in Western Australia, because they’ll only have 15 nationally. I’ve got to try and justify how we can be one of the 15 compared to Flinders or something like that. If the community’s not driving it because they don’t understand…at the moment it’s all too hard for me because the information isn’t user friendly or education friendly. If you had a Research Centre that had all the information… if all the information’s there it would help.

1.3.8 Regional planning/visioning

- One of the good things research could be used for would be help in any strategic planning, with the Shire and regional planning that gets done. But once again it depends on what research and what they find. We have been involved in strategic planning in the past. We certainly take an opportunity for public comment when they’ve been available.

- The thing is, there’s no marketing strategy for the town either. We’ve been asking these questions recently as the committee at the Visitors Centre. Ok, well where’s the direction? Where are we going with this town? What are we aiming for? Who’s got the plans? Who’s got the big picture? Nobody’s got any.

- We need to look into the future and say how is this place going to look in 10 or 15 years? Hopefully we’ll be able to look back and say we have done a good job. More tourists are coming but the place is still unspoiled. We can try our best to maintain that. We’ll always have our mantas and fish, and they’ll always be an attraction, but I do worry about coastal vegetation. We need to protect things now and into the future, so we can tell our grandchildren that we’ve done a good job.

- I think using the models and visualisations for a visioning process would be absolutely fantastic – that’s going to reach a lot of people who would never be reached. You can talk about the facts and figures and scenarios, and you can paint a picture in your head, but I think seeing it is really a lot more engaging, it’s going to have much bigger impact. And if they could do it so that you’re a person walking on that beach with this many people, or with just an aerial view of how things will look. I reckon that’s how you’re going to reach people as well like the shire, even shire councillors – pretty simple, visual tools.

- I think using the models for community visioning would be a really powerful tool, but so then what’s the outcome of that? Do people then go, ‘Hang on, we don’t want to have that impact on our fishing’ or ‘We’re not happy living up here with that many tourists’? So then I guess your relying on individuals to lobby the Gascoyne Planning Committee, because apathetic people aren’t going to do it unless they go into overdrive and panic. Or do you make it simple and at the end of the session you give them a pro-forma letter and say here, sign on the dotted line and leave it here and we’ll post it for you.

- An exercise like that would benefit the Shire’s vision because it would be more autonomous than them paying a consultant to write the report that they want written. It would be what the people actually want. It’s got potential but you’d have to market it cleverly. This new Gascoyne Planning Committee, that’s going to dance to the political drum of the National Party isn’t it? So is it really the best avenue for all this stuff to happen anyway? It’s very anti-environment.

- [a modelling run that looked at what would happen in the area if we were to take an industrial path rather than tourism] would terrify everybody, I’m sure, if they actually realised what’s going to happen. It would be interesting. The Cape Conservation Group would definitely want to have a look at it, that sort of end of the community. The other end of the community, the shops, the butcher, the baker, everybody’s making money out of the oil and gas industry being there, they’re probably just happy with what’s going on, thanks very much.

1.3.9 World Heritage

- We need to see [model’s model to see what it reckons going to happen with this World Heritage.}
1.4 Education & awareness

1.4.1 Educate the public

- The next level would be the community at large, and I am starting to do more work in this area now for the Ningaloo work in terms of mapping the key pathways required to effectively disseminate information.
- People living in Coral Bay are probably the biggest conservationists because it’s their business and their livelihoods. I worry about people who come here and don’t give a shit. So I see a role for the research is educating people about the area: here are the hard facts, these are our measuring sticks.
- It would be great to actually see that information presented to the public.
- There would be value in having research interface with the public, but it needs a focus, not done *ad hoc* by just me. I’ve heard conversations between senior management saying we need to do this. Get the message out to the public about the enormous amount of research that has gone on.
- I see the Tourism Futures model used in the future as an on-line education tool where the public can explore the links between the different parts of the tourism system (e.g. see that putting up a hotel in Exmouth will use a lot more power than a caravan park).

1.4.2 Information for tourism operators

- We’d be interested in the research on turtles, rays, just so we learn more. All we’re relying on now is all the information that DEC provides us, like water temperatures, what’s going on with the water temperatures. Yeah, the water is really cold this year, it’s only about 25 to 26 degrees. Usually by now it’s about 28 or 29. The other day, yeah, I jumped into the water and had to put on a wetsuit, and that was February. I don’t know what it is. Even in the Gulf it’s cold. But then it’s good because no cyclones will come here but, what’s going wrong? Who can tell us? Nobody.
- [Do you think any of the research can help you in your operations?] Just for information for our clients. I’ll give the information to the public because the public want information, they want the materials, and all the materials we have at the moment is what DEC supplies us with. Just tell us what we need to tell our clients, because that’s their job. Our job is relaying it to the clients.
- Tourism operators often use that information for their own practice and for just their client’s general knowledge, people enjoy learning about what they’re doing. There’s a lot of information that’s come out of research on the whale shark trips that people enjoy seeing.
- Some of that information would be imperative for the local community to know for its future. Some of it could be very entertaining and I’m sure that the tourists would like to perhaps get some of that information. When the whale shark industry take the tourists out, they could give them definitive numbers, info on feeding habits, timing, etc. That would be a nice dispersal of information.
- I believe people are looking for more information in general. I think with the internet we live in such an educated world that the basic stuff that you find in a brochure, you know, even a DEC brochure, lots of people know. Even five year old kids will come into the shop and say, “Mummy, that’s a whale shark”. Ten, fifteen years ago you’d show a picture of a whale shark to people and they wouldn’t have had a clue what it was. Now they’re learning it at school or on the internet or whatever. Learning is so much more accessible now. Because of that people really want more. Back in the old days you had the encyclopaedia if you wanted to learn something, and that was it. Or you had to go to the library.

1.4.3 Fostering responsible behavior/ownership

- It’s a shame given that knowledge should be on that ground level, because then you don’t need as much government policing, regulations, government officials in patrolling roles or site managers – because people will do the right thing, especially with issues like recreational fishing and recreational fishing pressure. People just don’t believe there’s an issue there
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- The landholders, managers and tourism operators are the hands feet and eyes on the ground. Every day, all day. If they know what’s going on they can divulge it down to visitors and the public, over which they have a lot more influence and contact than any of the Government agencies as they’re seen as a lot closer.

- Depending on what the research is and what it finds, it will get used. The research would give people more ownership, some more understanding locally on what things mean.

- Anything that increases people’s knowledge of natural systems will increase their caring about conserving the system. All communication of science to the general public is good, communicating the more complex processes especially. I’d like to see that happen.

- We’re talking about that with the Abrolhos as well, same thing. How do you value somewhere if you don’t know anything about it? And why do you protect something if you don’t know it needs protecting?

1.4.4 Models as learning tools

- The models can also be used as learning tools where they’ve got hands on ability to sit at their desks and play with it. There’s always a question about interpretation and experience, especially for the big models, but even if they make the odd error, it’s better that they get that overall increased understanding.

- The first thing people do when they get asked a question around here is reach for a report on their own shelf, ring a friend, Google it, then they turn to an expert who may take a while to answer them. If you can crack getting into that top list and not be at the bottom of it, that’s where you want the tool – a fast way to get information, to modify their thinking. Change the way they approach the question, the way they think about the world; give them ability to think outside their box.

- In a human’s head is a little physicist who can only think linearly about the world –everything only has very short links that decay with distance in a linear context; there’s hardly any feedback and no indirect effects. You have to change their thinking of the world so they think about complex interactions, especially feedback and indirect effects.

- When people are dealing with a complex system and they push it in a way that pushes back counter intuitively, the classic approach is to just push back harder to push through the barrier, which can get you into a mass of trouble. Or if you can change their thinking so instead they say: this is a complex system, and I’ve got to figure out where the feedbacks are and target those instead, and appreciate there are going to be lags in the system as well. If you can change the way they think about the world, that’s when you’ve won.

- I think you’ve got to model specific problems not entire worlds or systems, your aim should be to answer particular questions, not everything. We don’t want the model to expand infinitely. It’s an educational tool, an heuristic device for input into discussion and debate, it’s not an accurate representation of reality. It allows people to understand the flow on effects of different planning decisions, e.g. extra accommodation in Exmouth means we’re going to have to double the size of our power plant.

- I don’t really see the models telling people what the future’s going to be, it’s more like carrying them in the thought process and asking the right questions. What are the important factors and how they should interplay with each other and so on.

- I think they can probably make predictions without the model. I think the model’s predictions are no better informed than predictions made without the model. I understand that the benefit of models is that they force people to consider complex relationships. They force people to think about the interplay between factors. That’s good, that’s a useful way to be thinking, but when it comes to the sort of collecting data, this is not my thing, they’re maths based…
1.5 Market/tourism information

- There's been some tourism research done up here, I think it was Murdoch University or Curtin University, they did a whole bunch of stuff here a few years ago. But again, we haven't had those reports. They were looking particularly at whale shark passengers.

- We'd like to see a lot of passenger numbers research, actually where people are coming from, how long they're staying here for, what sort of dollars they're spending, who's staying in caravan parks, who's staying mid-range, who's staying high-end, what are those people doing when they get here, what tours are they doing.

- [With respect to the regional model for tourism] from a marketing point of view, that's business wise what we'd be more interested in.

- My impression is that basically DEC runs the whale shark industry. These guys they apply for a license they've got to meet all these fairly tough criteria, they get their license and they run their business. I think DEC really is conscious more about the industry so I can imagine that DEC would be more interested in those sorts of modelling questions around staff shortages with rising accommodation costs, etc. But they're probably not going to use it unless there are concerns raised by the whale shark industry.

- If we were focused primarily on accurately measuring tourism, we could invest too much time on collecting data and lose the emphasis we've got on strategic thinking and participation and engagement of people to help their understanding of tourism.

1.6 Bringing stakeholders together

- Which is what this research needs to do, it's the missing link, because you've got all these people with all this information and all these people acting on their own information, you can't get it together.

- That research and information must get out to the wider community, not just government departments or a few local councillors. In a perfect world we would have three or four different stakeholders getting together, keeping in mind indigenous stakeholders and a range of others, to discuss it as a group. Yet at the same time you don't want to have a million different steering committees because nothing gets done.

- I strongly believe we need to bring together different stakeholders, the Shire, GDC, whoever. Get people on the ground for half a day so they can share their issues: DEC can show their issues, the shire can show there issues, the GDC can go, well these are our issues. So if you can be some form of catalyst for all that it would be good.

- We get a lot of flack from GDC and the Shire. But I look at them and I understand what they're doing, they're flat out, we know that. But I don't think a lot of people in management/decisions, from the Shire, councillors, etc - people who have written to the Ministers and made such noise about DEC—they don't actually see what happens on the ground. They know there's a park out there, but they don't see what management issues we deal with under the Act that we're governed by. It would be great to get them out on the ground too.

- Because I do feel, from DEC's perspective, there is a change. I think a lot of that animosity came from the sanctuary zones. So when you look at it, you go, ok, this might be a good opportunity because all the research has been done and it's nearly coming to an end. Let's bring everyone together.

- A lot of people say to me, oh, what's the point of World Heritage. And maybe it doesn't do anything for the land value, maybe it doesn't do anything for the marketing, but it creates one peak body that brings people together. Like Shark Bay, if you do research anywhere in Shark Bay, DEC are across it because they manage the whole World Heritage area. So in a way that's effectively how you get everyone to work together.

- Well, even looking at the guys who did the speleology, the caving, they're doing research, but then DEC sort of stumbled over the fact that, because they're in the caves and they're doing the work, let's see if we can get some money for this research. But it was only a lucky connection. I think that's what we've got to avoid, just having something slip past that no one is even aware of. And once again I suppose it links back to that Research Centre as a hub.
1.7 Addressing cultural concerns

- The Ningaloo coastline is of very high cultural significance to the Baiyungu people. It’s a very precious area because there are burial sites all along the coast in the dunal areas. We want people to enjoy the Ningaloo Coast, and we want them to have great respect for the area and take care of it.
- Certainly would like to see cultural concerns included in the research. You can’t argue with 40,000 years of occupation.

1.8 Supporting funding

- I see the Tourism Futures model used in the future for creating a story for the funders so they can see what their money has contributed to and how it has made a difference in the region. Senior management needs to address this.
- I do recall [redacted] saying that a lot of the work that’s done would be designed so it could be used by the local government, particularly in relation to showing the gaps in funding local government services because of the influx of tourism that we get, here, where the permanent population is 2,000. They were saying our model should be able to demonstrate that if we increase tourism by this much, the demand on local government is going to be this much. We should be able to use these results to go back to the Grants Commission and say, well hang on a minute, you know, your basing your funding on this when really we’ve got to deliver this.

2 Promoting research uptake

2.1 Promoting ongoing use of research

2.1.1 Hire a research coordinator

- If you are going to do that, you would need a coordinator and how many hours you would need, I don’t know. I think once it’s up and running it would probably wouldn’t take too much because you’re only updating the website. It’s just getting it up and running, and, I mean, in terms of a web site, rather than an actual individual website, maybe DEC would be happy to tack it on to their website and have a link there.
- [Do you think a CCG or community member would be interested in taking on a volunteer role to help get the research out to the community?] Well, it might be. I guess it would depend on how much time it involved, because one of the problems obviously we’ve got with CCG at the moment, is that we don’t even have a committee, and this is always one of the problems. So the other possibility is to find funding, whether it’s through Lottery West or Coast Care or whatever, and then there’s the onus on that person who’s got that position, even if it’s part-time, to continue to find funding.
- Oh, I’m sure there’d be someone interested. It’s the sort of thing I’d be interested in but it would again depend on how much time and involvement. And I’m sure there’d probably be someone in CCG, someone else who might be interested. But because of the array of people coming here, it probably does need a coordinator to make it all gel.

2.1.2 Promote ongoing relationships between researchers and region

- I have confidence that research will continue for a long time in the Ningaloo region; even though the cluster’s work is finishing other work will follow. A lot of the cluster’s work is just baseline.
- There’s a slow changing of the guard in CSIRO with a lot of the older scientists getting ready to retire. There are opportunities for a younger scientist to become interested in an area and then maintain a relationship with the area for 20-30 years of their career. We wanted to take that idea one step further have a dual focus in Australia, (maintaining these focuses, while taking lessons learned to other places)
with Northwest Shelf-Ningaloo as one region, because it’s a high value natural resource region but with growing population stress issues. Then at the other extreme concentrate in the SE of Australia where there is already high population and a long history of exploitation. So you’ve got the two extremes to learn from.

- Momentum could come from stakeholders on the ground to see long term involvement of scientists in Ningaloo. It’s happened in the fisheries world.

### 2.1.3 Have a “leave something behind” strategy

- I think some of CSIRO’s capacity building projects in the regions failed to build capacity because they never left anything behind. I began to question the ethics of investing public money and raising expectations about something that isn’t fulfilled. I’m sure this wasn’t intentional – they’re quality people - but these scientists don’t want to live in remote areas and they have to make a living.

- But now its mop up time for Ningaloo, and roles of the cluster management committee probably needs to change for this next phase of the project. We need a ‘leave something behind’ strategy rather than an ‘exit strategy. The management committee needs to put resources into this strategy, which will take a change in who people talk to and about what.

- Our next steps need to be focused on leaving a permanent presence in the region and creating a network that will support the use of the research.

### 2.1.4 Apply knowledge transfer framework

- Chris and Kelly’s knowledge transfer framework is an excellent first start – they’re hearing the issues that have been raised about how the research will interact with management. The only problem might be that they are marine people; they won’t necessarily identify or be aware of terrestrial issues. There could be a gap in integrating the marine with the terrestrial management – it’s something to be mindful of.

- The key thing at the moment is to get the knowledge transfer framework right: get the formats right and get the implications right.

- We haven’t really discussed this knowledge transfer matrix specifically with [_____] – we probably should. We can take the framework, once its fully fleshed out, to [_____] to make sure these are levers in her model and see how they’re applied and then to help us identify which are the red light ones that we should be working on first.

- Information about what research the pastoralists etc. are interested in, their views, etc. would be useful for us and the NCC management committee because we’re talking about how to get information out there, like a road show, or posters on particular projects that [_____] can put up. You could increase our users and use our draft knowledge transfer table to identify what information users would like, areas where they see applications for the research, and some of the outputs they would like as well.

### 2.1.5 Create a regional body to use the research

- There’s need for investment in a permanent body in the region to do all these things, but it shouldn’t be imposed on the region by government. The Great Barrier Reef Marine Authority is an example of a regionally situated office that houses all the modelling, research, etc. done in the area. But I think it was an imposed federal thing that probably didn’t sit all that well with the farming community etc. GBRMA hasn’t been as effective as it should be and that’s because its government driven – something like this needs to be driven from the bottom.

- We need to think about activating the community in getting a long term sustainable body to look after Ningaloo - preferably without relying too much on the commonwealth government - and incorporating a lot of local input and a bit of independence.

- A Swan River Trust model is needed for Ningaloo because it’s not reliant on one strong person, as is the case now with [_____] Someone (even if they’re not that familiar with Ningaloo) who is a good chair,
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familiar with natural resource management and who can bring parties together would be able to pick up much of [David’s role].

- With the research base we have something like the Swan River Trust would be ideal for Ningaloo. The board could be staffed by private individuals who know about the area and have different skills, ensuring local ownership and good will. The CEO would report to the chairman of the board, who could be someone like [David Wood]- respected, knowledgeable, and known and accepted by the community. But the chances of getting something like this for Ningaloo are probably zilch. And they definitely won’t invest in something like this if we don’t package up our science.

- We need to harness the public’s interest in the area to float the idea of a Ningaloo Trust – now. We should start talking to Friends of Ningaloo, give them a summary of what the science says so far, and say we’re worried that the science won’t be used once the scientists disappear, that we want their help and to consider something like a local trust to carry on and use the research we’ve done. Perhaps this could become their next cause de celebre. Then we go to the decision-makers and ask for something more modest – like resources to train and set up someone locally to run the model for the next five years.

- The Swan River Trust model should be looked at for Ningaloo – a body with local representation and staffing, but with proper resourcing.

- The SRT engaged the Swan Catchment Council, applied for research dollars, started a clean up program that actively involved people in data collection, done water quality monitoring, been involved with planning, and talked to the public about littering, etc. – their work keeps the Swan in the top of people’s mind, even if it hasn’t fixed the river. They are really well liked by the community. It’s a way to have the public take responsibility for resource management.

- The best example I’ve seen was in the Herbert Catchment many years ago in northern Queensland. The top of the catchment was totally divorced from the bottom, and they were trying to do catchment management. They set up a GIS system and the local government housed it in their office and contributed to its maintenance. The community really related to it, and I believe it is still there. It also created a bridge and better relations between a difficult local government and the state.

2.1.6 Avoid creating new institutions

- A model like the Swan River Trust would be resisted by DEC, for very good reasons. If you look at other groups that sit outside the reserve system, e.g. Rottnest Island Authority, they’re often not at the table when things happen. It would serve the self interest of certain people in that area, because they could have more control over a local management authority. If you had Ningaloo Management Authority, like the Great Barrier Reef Management Authority, then what you have is a politically and economically isolated entity, that will become a much lower priority for the DEC to engage with. The DEC will focus on the reserves within its responsibility to manage. At this stage we do not need more fragmentation and isolation.

- Instead of making more government structures, people should be looking at how to improve the structures that exist. I think structurally we’ve got as good as we can get, the issue is making the structures work better together, including better integration between them. Even though the natural reaction is “let’s have another structure”, this just creates another level of complexity, so it’s going to be even worse. They naively think one agency will have power over everything – well it won’t, because cabinet ultimately makes the decision, the reason the NSDO is being dismantled is because of politics.

2.1.7 Partner with landholders and tourism operators

- Let the private sector, whether it’s the landholders, tourist operators or businesses in the towns do what they do best and offer what Government cannot provide due to resource constrictions. But Government needs to establish and enforce the benchmark.

- Disseminate the research back down to the landholders and tourism operators. Don’t just leave them out. What is needed to be asked is: ‘Are these issues that we can work together on? What should we move towards on the ground as a result of this information / research findings?’ If that is something that DEC
and the Government would do, it would be of fantastic assistance. Landholders and tourism operators don’t have the resources or time to do this. But Government does it well and have the resources for environmental education: pamphlets, newsletters.

- Government does certain things very well: it is strong on science, on research in partnership with universities and on public education. But then the information and research findings need to be applied and executed (through partnerships with the private sector who manages visitation on the ground). We’ve got to change hearts and minds if we’re going to look after the resource and leave it in the state, or better than, what we found it. But the problem is that the hearts and minds that have to be changed belong to everyone: to the Government, universities, researchers as well as to land managers and the public.

- If you want us to help you, get the right information in our heads and hands and we will action it. We move forward as we understand the key priorities and pressures to be, and can move forward in a direction that’s good. I know all the pastoral landholders on the reef and there is not a single one of them who do not care about the environment. That doesn’t mean that things cannot be done better.

- Considering the ongoing constraints caused by lack of government resources, lack of personnel. Like it or not at some point in the future, Government will have to use the available resources, hands and feet on the ground and relinquish some power and control. We [landholders and tourism operators] are the people in the trenches dealing with on-ground issues, the whole day every day, over and over. If we know what’s going on and have the relevant information and recent research findings, it equips us to better deal with the public and to feed that information through to them to change patterns of behaviour and encourage sustainable use.

- For a pastoral station to be viable, you need x amount of head and sorry… It is all about camping. Great! I’m not arguing with that, so let’s work together and manage it, work it. I’m a very strong believer that everyone can learn from each other. I don’t have all the answers. Tell me how does a station work – what are your issues? Because what your issues on the station are, are going to be different to what my issues here are. Ok, let’s come up with a resolution. How do we resolve this? I actually get on with the pastoralists quite well. There’s a very healthy trust there.

- As a skipper, has a real passion and genuine desire to be doing more out there, because he’s worked out on the ocean all his life, so he sees things every day, weather patterns year after year, all the elements and factors coming in, and he has his own theories on what’s going on. When he chats to different researchers, some of it actually just starts to gel together and he’s got all this anecdotal stuff to offer, observations from over 20 years on the water brings stuff together.

- There’s an array of stuff that you can do as an operator, and we’ve put our hand up to all of them and said, ‘We’re here and want to do it.’ I suppose it’s a trust thing for the scientists too, knowing they can trust us in gathering the information correctly. The main thing is it’s about relationships and about trust, it’s about us being happy that it’s a two-way street too, that the flow of information gets back to us.

### 2.1.8 Host forum to discuss research applications

- could aggregate the research/information, then put it to an internal forum of DEC area specialists then let them decide what information is relevant to their areas of work and how they can use it. This would also create synergies between people at the forum. Invite people across DEC, not just marine. It would help build bridges between marine and terrestrial branches.

### 2.1.9 Post follow-up research opportunities on website

- I was talking to someone from the zoo the other day, down at the Abrolhos, and they said what they do is post the research they’re after on their website and that’s how PhD students or people looking to do a PhD do it all for them. But even that option of getting PhD students to do your work for you, why not? Their budget might be a million bucks, but they’re getting $10 million worth of research done a year.
2.1.10 Integrate with other research

- How Amanda Smith’s data will be integrated with DEC visitor planning is a question – not sure what DEC is going to produce. It would be good to talk to Amanda Smith, to see what she is aiming at producing, and what formal processes she is setting up for long term gathering of data. We have ViISTAT that does visitor numbers, but going further than that I’m not sure. And I’m not sure how this links into research projects, or how their data will relate to what DEC does.

2.2 Promoting ongoing use of models

2.2.1 Make models accessible

- From a practical level, if all of this research is happening and it’s all feeding into models, how can the average person access that material? If we want to do some research on here, say we’re going to look at litter on the beach, or what happens if resident usage increases from 100 to 200 people a month or something, how can we actually access that model? Do we have to pay for it? Do we have to go through specific people? Is it going to be accessible via the web or...how’s that going to work?

- I think that the model needs to be accessible by everybody. Why spend all that money on all this research if it’s not? Because if someone can use it, even for the tiniest little decision, such as ‘hey we want to hold an event here that might attract 1,000 people for an event, what’s that going to do?’

- How do we access the model?...is it going to be a user-pays system or...? It’s $30 million dollars worth of information, you’d reckon they’d keep it alive. The more people that use it, the more the cost comes down, doesn’t it?

2.2.2 Simplify models

- We’re committed to trying to make this work but we need the model results simplified to the point where we can understand what the resource trajectory will be for different plausible management scenarios, so the average person sitting in the GDC can see how everything is connected. It’s going to be difficult; we will try to gear our long term monitoring programs to track some of these things, through choosing relevant condition indicators. If our indicators show a downward trend, we can have aspects of our monitoring programs aligned with the indicators and trajectories of the model so we can fine try to fine tune the mode.

- What is going to happen after this round of modelling workshops? We’re going to look at a general user-friendly interface for the model; I can see that as probably the next priority

- If they could set up some kind of program so basically you’re just putting in the data and its spitting out the results. For example, let’s find out the effects of increased visitor usage at Tantabiddi during the summer months. Put in those numbers and then check the impact on turtle mortality or whatever. Something on the web would be great; it would have to be fairly simple though I think.

- I do like the idea of having simpler models being step-by-step accessible via the net or on a CD or something. I guess that’s going to be your lowest resource option ‘cause you’re not going to be paying someone a salary to plug it, do it, distribute it.

- What would be fantastic would be if you could get a disk, whack it into your computer at home, and it’s almost like a step-by-step process of collect your data like this, input your data here, import x, y, z. I don’t even know if it’s possible, but something like that would be fantastic. But it would obviously have to be pretty simple, I would imagine, I don’t know how well these things work when it comes down to the technicalities of it, they’re probably really complex.

- We’re building toy models, intermediate complexity models (e.g. Tourism Futures model), then the full, really complex MSE model. There’s only two ways these models will stay alive in the long term – one way is to continually ask the model strategic questions, the other is to use the model as a learning tool.

- The toy models will help people with their complex systems thinking, the intermediate capacity models will serve as tactical tools that day to day managers might use into the future (e.g. sit on the desk of someone
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in the Shire), and the complex MSE model will give them basic guidelines on where to head into the longer term.

- The models they’re creating at Curtin (e.g. Tourism Futures Model) are the tactical tools that might get used day to day, stuff that you can run on your desk top, which you don’t need to run for days to get answers. We already inform each other about model structures and processes.

- You can compare outputs of the simpler models and the complex ones and see where they differ, figure out why, and see if you can capture that component in the simpler model without having to go to the full complexity (e.g. put in a humped relationship instead of a linear one). This way the simpler models can still have the fast turn around time and be in a form that’s easily played with by non-expert users, but still have the non-linearity and the lags in the actual model system that’s there to inform the managers.

- There’s development of gaming software (a Ningaloo game) from the MSE model, to allow people to play with the system and various management options. A very simple example of this was presented at the workshop at Exmouth for the interaction between tourism, infrastructure and marine environment. Developing a Ningaloo game.

2.2.3 Use visualisations

- [They’re looking at building special visualisation software for showing how things will look, ex. at Turquoise Bay if you add 500 more beds to town]. Good. To hear there will be 500 more people on Turquoise Bay, they may go, ‘oh, that’s awful’ but when you actually see what it looks like, well maybe, it doesn’t look like that many more people.

- [Do you think the community would be interested in seeing visualisations of what the place might look like under different development scenarios?] Definitely! People are going to engage with that. By doing that I think firstly you’re going to be able to reach a lot of people that you’re never going to reach by standing up and talking from that research. It’s just going to go completely over their head, they’re not going to get it, they’re not going to be interested in it or engaged by it. If you can give them a visual of ‘this is what Turquoise Bay, the beach is going to look like with this,’ I think that’s absolutely invaluable. If that could happen, that would just be brilliant.

- Yeah, I think definitely visuals that depict the modelling results. I think a picture paints a thousand words and one of the problems we’ve had with fairly complex issues like World Heritage, is actually communicating the facts to the normal sort of person. And I think if they can get a picture of what the gulf was going to look like with 20 oil and gas vessels in it and Panamax bulk carriers, definitely they’re going to go ‘Woah, hang on!’

- But I think that’s where those visuals of the modelling results will be useful, because I don’t think a lot of people are able to go 5FPOs, Straits, barge lane facility, limestone export, etc. ‘Oh that’s going to mean a lot more boats out there and a lot more vessel traffic.’ I don’t think they can go “this equals this and this is what I don’t want so therefore I need to lobby against this”. That equation doesn’t work for most people.

2.2.4 Hire someone to support/promote models

- Speaking from a community conservation group perspective where you’ve got limited knowledge, limited resources, and limited time, if you could phone someone and go, ‘Ok, DPI’s got this proposal. We’re concerned about A, B, C, D, E, F, G; how can you help us?’ And they can go, ‘Oh well let’s plug all of that in the model and there’s this paper and this paper,’ and put something together, how fantastic would that be? And there is no reason why the Shire couldn’t perhaps do that too, say we want to put a road out here, what can you do for us? Anyone could use it. But again, I think we have to go right back to where we started in terms of, if that service is going to be available, it’s going to have to become part of the culture. I guess to justify the salary and the training and the resources and everything else going into it, the person would have to be employed at least part-time.

- If there was someone trained in using the models, particularly the more complicated ones, you’d have to almost market the models, because if stakeholders don’t know that they are there they won’t get used. You would almost need to run like an awareness program, like training workshops to actually show
people what they’re capable of doing. Because if people don’t know it’s not even going to enter their head to use it. You almost need to make it part of the research or development culture, so that if any development’s happening up here, one of the key things you do is plug some stuff into the models and see what comes out. For people in the region to say “did you run that through the model?”

2.2.5 Collect questions & run scenarios

- Our approach at the moment to understand the MSE is to give some scenarios to run through the model. In terms of the connections and the starting conditions for the model, which you know are critical, there are a whole lot of assumptions that Beth and her group have been addressing.

- We’ve just done a bibliography for all marine environment research between Kalbarri and the Northern Territory; $250,000, and its up on the internet. We’ve asked: who is going to be custodian of this, and we can’t get any response because everyone’s budgets are being cut, they can’t fund what they’ve got, and no one can add programs. These are the practicalities. That’s one of the problems for the MSE, if it can’t be reduced to something very simple, it won’t have any life beyond this study, and we have to accept that the products produced in the timeframe of the study are the only things we get out of it. So we come up with the scenarios and run the model for the scenarios.

- [The modellers are planning to run a series of questions through the models before the end of the research project, and they’ll probably compile the answers in a report.] I guess it’s better than nothing but that’s only relevant in a given point in time isn’t it? That’s just like putting it in a journal and sticking it on a shelf in a library somewhere. Sorry, I’m a bit of a cynic. I need to see it’s workable and useful.

- It’s amazing to be asked, ‘What do you think the model could be used for? How could we use the model or make it more effective?’

- Getting people to know who and how to ask questions of the model involves a lot of time by me and the team on the ground and it has mixed success. In areas where they’re used to this kind of approach they clue in very quickly and know what kind of question they want us to follow up on. In Ningaloo, where there are some parts of the system that aren’t used to it, there’s lots of hesitancy. We’ve had to repeat ourselves over and over for people to understand where we’re coming from.

- I think you would have gauged from the reaction of the CCG that there are actually lots of questions from a variety of areas that people are interested in asking. There are a lot of questions that people are interested in asking about. Are you taking those sort of questions out further than CCG, like what questions you’d like to ask the models?

- It might be worth compiling a couple of examples with the modelling, and using that to say ‘here’s an example of what you can ask’ and saying ‘well, here’s some topics you might want to ask about – water or population or whatever’ then seeing what people come up with. So people can get a bit of a gauge...because it’s kind of a big, out there question.

- It would be worth asking user groups about scenarios that could be run by, although I’m not sure who has talked to, in terms of the Shires, the GDC etc. It’ll be worth getting their input, to see if they’ve already provided with the scenarios.

- I wonder if it might be worth me compiling the questions about oil and gas. That is on my list of things to do is to get some input from people and see what questions they have. I’ll get that to you and some topics of what they are.

- Meeting with the modellers makes sense to me; it’s just a matter of the timing and working in with the other managers. It would silly for us not to try throwing the questions in now and have the work they’re doing deliver something to us that is going to be of use to us.

2.2.6 Train people/agencies to use models

- We need to educate the right people, in getting the tool and playing with it on their desktops. The DEC manager in Exmouth, or Shire of Carnarvon for instance. We can identify the right people using the egonets and prepared. If we can make using the models part of the role definition of the key
nodes, then we stand a much better chance. If you make the modelling tool the way stuff is done, it will maintain engagement with those key nodes, largely regardless of the personality involved.

○ The Shires are interested in getting access to the modeling and see it as something that would benefit them. We have to find a way ensuring they know how to run the model without manipulating it for a certain result. It’s very difficult to run these things without understanding the data that sits behind it and that’s probably the key to this. We’d probably discuss what they’re interested in, and give them a sense of what the model’s capabilities are, then run a set of model runs based on those discussions and produce a report.

○ Prior to the project completion we’d run an engagement process with whoever will have control over it, to hand over the information and model. But it’s fraught, because the model isn’t vested in an ongoing research centre such as [blank]’s model is. It’s one of our milestones to have discussions with key bodies about taking over the model, and in the first months of next year, we will be training people and putting processes in place in which the model can continue.

○ Then once we’ve got this version [of the model] that’s a bit user friendly, then probably the next thing would be to look at training people and finding custodians for the model, and in time passing on the responsibility to the stakeholder rather than being seeing as the ones who ‘own’ it. Yes, that sounds like a pretty good model in terms of stakeholder involvement and empowerment.

2.2.7 Conduct model demos

○ We haven’t had tours like that [modelling road show], which could potentially be tremendously useful. People haven’t thought enough about what the model could mean. They haven’t been exposed to it [the models] enough yet. It could be great to help understand the potential of development projects. I think it’d be great. If you can pave the way for the modelling road show in October [2009] it could be a really good presentation. It would be good for people like our Board; a lot of the Carnarvon members wouldn’t know an awful lot about it. They’d really benefit from either going to a presentation or perhaps even getting a couple of people presenting to the Board. Maybe down in Carnarvon I could arrange to get some of our project officers together. In fact I could get some of the Carnarvon Board members and we could do something in Carnarvon which is looking at just Carnarvon. Perhaps with your direction we could work through some scenarios or questions, like you said. Or we can have a sort of think tank with you or whatever. I think we’ll be a part of that. There are different ways you can do it.

○ If they’re going to bring the model to the region on a road show, they should prime local people about what the model can do first, so they have something to chew on and time to come up with ideas and questions, rather than being put on the spot.

○ It’s important to provide the locals with example of what the model can do and how it might work before the road show. You could email something around, put notices up on notice boards, and speak to some key stakeholders about the model beforehand. Otherwise people won’t know what to ask.

○ [Well, and that’s one of the things like [blank]’s model can look at is the types of visitor that have different demands for energy and water and things like that, and that’s one of the things that the model can look at. Are you guys interested in seeing what these models can do, running some scenarios through them..] Yes, absolutely. It would be good if all this knowledge comes out and all this data is collated, it’d be good if you could have a series of workshops on the ground in the area. Yeah, like have one here and then Cardabia and Minilya and a few of the others come here or at their place and we’d go there. Yeah, and you could have like a proper fieldtrip and say, well, this is what is in the Gascoyne Strategy and this is why it isn’t going to work. It’s wonderful that we’ve got [blank] next door and we’re in close contact all the time, and yeah, we’re all eager to learn and... well, fundamentally we’re looking at protecting the resource – be that the marine life, the stability of the coastline, whatever. Probably either November/December, mid-November to just before Christmas, or early in the New Year before the onslaught, you know, like March-April.
2.2.8 Evaluate & update models

- The model will need to be assessed after 5 years. You wouldn’t need to collect all the information again; rather you could assess the basic data against Tourism Research Australia information on visitor numbers and expenditures, and then run some local interviews. We need to set up a process where the model can be updated relatively simply after five years. After 10 years you’d probably have to collect all the information again to avoid errors.

- In the next year we need to set up a process where the model can be critically evaluated, say in 5 years, to ensure the decisions made are having the impacts the model said they would. This is an important feedback loop.

- It’s also important to have some entity which can update and evaluate the models, and commission further research etc.

2.2.9 Build trust/Interest in the models

- At the symposium, someone got upset that our very simplified toy model showed tourism having a negative effect on the environment. This flags to me that we have to be careful how we inform him about what we’re doing and bring him along in the process instead of him feeling imposed upon. It also highlights we have to do some major education. It’s a common perception in the public that best practice equals zero environmental impact.

- There’s no way local people would have the same level of faith in our modelling results without David Wood’s long term involvement in the area. He demonstrates the benefits that come from being involved in a particular location and topic for 15 years. You can do a lot more. Over time there’s a build-up of trust and respect. Because he spends so much time up here on committees etc. people can see that he’s committed to the region, even if they may not agree with everything he’s done.

- Because the stakeholders identified the questions going into the model they have more faith in the outputs. But I think that would have improved by using a smaller group of stakeholders to actually build and understand the model. If you’re involved through everything you’re going to have a higher level of engagement than if you’re involved at various points in a process. I think we’ve probably got the latter.

- I went to that first modelling workshop that they had, it must have been 3 years ago, when they were actually setting up the models and it was scientists and the modellers from around Australia here to work out the model. For some reason I ended up at this day. I think we were the only non-science people there. And yes, it was very interesting to see that process. But it was very like ‘oh my God’ …we were exhausted after two days of...our brains were exploding.

2.2.10 Address red tape & triple bottom line in models

- I just think that red tape needs to be one of your criteria in the modelling. And the impact of not having triple bottom line as a base argument behind anything. Everything is environmental. It is just purely 100% environmental, and that just doesn’t work. It works if you’re sitting in Perth and you’re trying to get votes from the minority groups, well and good, you’ve done a good job. But as far as the regional economy goes, it’s absolutely stifling.

- The model needs to have in there some part that says planning might take another three years or 2 or 3 million dollars to get passed, so if someone comes in and wants to start a greenfields set up, they’re going to think, ‘Well hang on, if it’s going to cost me another million dollars just in planning and it’s going to take me another two million dollars before I start to get a return on my investment, well, bugger that, I’m not going to do that.’

- So it definitely has to be part of your modelling – the ease of getting tenure and being allowed to develop the coastline. I try not to be negative about everything, its just that they’ve missed out on some of the hurdles on the coast in the model. If the big hurdles were incorporated in there, it would make it even more accurate than it is now.
### 2.2.11 House models in the region

#### 2.2.11.1 General

- Firstly, in the short term, conversations need to be held with Shires and the GDC to see whether we can put a proposal together for someone to man an office and use the model to produce simple outputs. We can probably sell this at a local and regional level.

- We need someone to invest in a home for the MSE model. From my experience, that home needs to be in Exmouth or Carnarvon. There’s a need to inveigle the local and Commonwealth governments to keep an office in the area for 5 or 6 years. This isn’t very promising given what they’ve done with the NSDO, which would have been a perfect place for it.

- You could come to agreement with 5 or 6 agencies (e.g. GDC, DoF, DEC, Premier and Cabinet) putting in a bit of money to keep the MSE model housed regionally. At the moment you should be able to broker the resources through Premier and Cabinet because it’s all National Party country up there. It should be a priority issue: as a state we’ve invested all this money in research, we don’t want to see it wasted by not using the model in the region.

- I don’t see why the Commonwealth shouldn’t invest in a local office for the model – it would be a natural place for this new CSIRO coastal place to put some money into and actually operate out of.

- The model also needs to be run by someone who is local and who can answer questions using the model. As personable as Beth is, she can’t be there the whole time.

- We need to think what to put into a local office like that, and how to get people confident enough to come in and ask questions.

- We’re also looking at where the technology (models) should reside and how you build capability to use it. It could be located in the Ningaloo area, although the custodian would probably be in Perth.

- The Shire is interested in having the model housed in the region, as it’s important from a local and regional planning perspective. We need to be able to use and update it.

- Probably be easiest to make that model available down at DEC. Or the Visitors Centre, yeah, yeah, they’re unbiased.

- In the long run, I think we could leave the model with an agency where people have an understanding of how it works, and give them access to myself or Jean-Paul – we can assist until June next year when the project ends. It could be used in a collaborative sense with different groups to inform their planning processes.

- We’ve worked to build strong relationships with regional planning bodies (e.g. GDC, NSDC, and hopefully Gascoyne Regional Planning Committee), so they see the model as worthwhile, because they’re the ones with the funds to keep it going. Unless they want to pick it up, the model probably isn’t going to run beyond the end of the project.

#### 2.2.11.2 GDC

- Regionally the GDC could play a role with [training someone in the region to use the model and make it accessible to local agencies and people]. The GDC is the place where it should be driven. I’ve got a feeling we really need two GDC officers in Exmouth rather than just the one. It could be the catalyst to get the second one here. The GDC has given the Exmouth officer a lot of focus on the oil and gas industry, so she could be a great link.

- Maybe we need to work through the GDC to see if we can get a second person here to help with the models.

- I mean, the GDC basically reacts to community and others, and supports companies based on their research. It’s a mediator basically. It could still be the way to drive things like the bureaucratic side of development plans. The NSDO isn’t there anymore, and we don’t know whether the State Planning is still
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going to rehash it or not. The GDC could be the frontline agency that liaises, if they were to get better funding.

- Ideally it would be great to have someone like the GDC being the model custodian and then each agency having as a point of contact someone who’s got a bit of understanding of computers or computer programs or whatever. So an informal structure with different points of contact.

2.2.11.3 Gascoyne Regional Planning Committee

- Giving the Shires use of the model is key. In some ways I’d rather have the models vested in an agency, at the regional level. The NSDO would have been ideal, but now the new Gascoyne Regional Planning body may be a place where the model can be vested. It’s just a matter of how are they resourced, which is an internal DPI decision. We had a good relationship with the NSDC, but its membership won’t automatically roll over into the Gascoyne Regional committee, which is a bit of a shame because the NSDC would have got on the ball straight away. If there was a staff member there who had time I could train them in how to run the model. They could be in charge of facilitating a regional meeting once a year where people get together to discuss tourism issues, where the model informs discussion.

2.2.11.4 Shires

- Exmouth Shire has indicated they are interested in having the model handed over to them, which I think is a fantastic sign for us, we just need to negotiate how that actually happens. CEO of Shire of Carnarvon was keen to use this research in their future tourism planning as well. This is the result of a lot of hard work and time put into running public forums in the region, individual meetings with representatives of the shires (20+) and different groups (accommodation providers, operators, Aboriginal Corporations, utilities companies, etc.), and dissemination of information that we’ve gathered through the project—we’ve been constantly doing that over the last two years. So we’ve got the avenues in the regions to get the research fed in, but the issue again is longevity and what happens after the project finishes.

2.2.11.5 Ningaloo Research Centre

- The NRC would be an ideal place for the Tourism Futures model

3 Engaging stakeholders

3.1 Identify stakeholders & plan engagement

- NCC need to find out who they want to influence and why. This needs to start now, because we only have until next year, which is a very short time frame given how busy everyone is on projects.

- We’ve recognized stakeholders for knowledge transfer (who we want to engage with in transferring research results and management implications) at a broad level: state agencies, federal agencies, regional people and Perth based people, but we haven’t gone beyond that at this stage.

- The cluster management committee will decide who will receive the knowledge. Shires and the GDC, particularly the planning group, would be targeted. Local people want to use some of the technology – they’re very keen to have Tod’s tourism futures model. There’s also some engagement needed at the political level.

- Local people can help define who we’re going to talk to and the framework as well. They could provide some direction about who you need to bring together – it will be one of the biggest linkages between what we’re doing and what you’re doing.

- We have to sit down as a coordinating group and identify who we need to lobby and about what, then systematically spend time doing it.

- This needs our energy now – and the cluster three leaders are very busy. We need to mobilize the Kelly’s and communications people in CSIRO etc. to help us. We need think systematically about who we need to talk to. We
need to understand what resources we’ve got with David, Neil and Bill, and I, how much we can do with those resources and where the shortfall is going to be. This stuff all has to be thought through very quickly and resources provided. There are heaps of conversations to be had in the very near future.

- If we’re going to work as a team, we need really good connections between disparate groups. It’s the old rule: focus 70% downwards, 20% on the next layer above you and 10% on the layer above that. Whereas a lot of people think: I’m not interested in the layers above me, I’m only interested in the things I can directly influence, so it’s 90% down, and a little bit up.

### 3.2 Target stakeholder groups

#### 3.2.1 General

- In terms of users we’ve been focusing mainly on government agencies, the ones who make and implement strategies, but I think we need to reach out to the pastoralists, operators and local government too. The users should not be confined to the statutory government managers, but should be as broad as we can go.

- By being tiered and nested the models can provide advice to different kinds of people at different levels in the system: to politicians at the highest levels; to government departments on how they put their regulations in place, compliance and enforcement issues they’ll face, unexpected consequences that could undermine the intent of their regulations; and to individual operators on things to be aware of that might trip them up in the future, or small changes needed to bring them in better alignment with management intent. The models can be used to reduce conflict between the different levels, create greater transparency and understanding, and potentially even greater economic efficiency. For example in the fisheries world, you have NGOs, politicians, management authorities, and fishers all asking questions of us simultaneously.

- I think definitely, rather than making the research specific for one user group, make it as broad as they can. Up here it will be local stakeholders like the shire, the local office of DEC, Local government, DPI, Fisheries and obviously the Cape Conservation Group, although you just don’t know what’s going to happen in the community sector.

- Local accommodation I know, is going to go mm-nah. A local tour operator is probably going to go it looks pretty hard. DPI - depends how engaged their specific individuals are, they might go oh yeah, that could be interesting. Probably a lot of government – but I think you really need to highlight the value of it with them as well.

- The question is, the process of engagement that’s so crucial to getting these projects going, how do you get that running beyond the life of a project?

- Need to go to key people separately or set up a large meeting with a broad group of stakeholders and then push that meeting as hard as you can for the month before hand to get people excited about it. We’ll probably do this for our final modelling workshop this year, to kick off an ongoing process in the region. But beforehand we’ll work to have some key people really engaged.

#### 3.2.2 Politicians/Cabinet

- My ultimate audience is a senior person in Premier and Cabinet, to impress them.

- I’m worried about us just being another project. Unless we’ve made an impact, the government won’t fund further research, and for once I actually think there is a legitimate claim for more research in Ningaloo. We need to pull together a primer stating the impact of what’s been done, and making a good case for more research, otherwise this government won’t see value in creating more knowledge for Ningaloo.

- We need to package the research, saying what we’ve done and what it means, for particular, e.g. upper level cabinet. And not just at seminar level. Unless we explain why it’s important to interrogate [the model], which ultimately integrates all the research, we’re not going to get very far.
We need an officer for the head of the department of Premier and Cabinet to go to them often and say: this is what the Ningaloo people have done, these are the ramifications, this is how we should use their work, there is a need for investment in the local area, these are the reasons why, and here’s the benefits the state will get. If this doesn’t happen I don’t think we’ll go very far.

We should prepare a quick and easy ‘policy brief’ outlining the benefits of research uptake for the state, the risks and uncertainties, and the priority areas needing future investment and why. This should be developed in collaboration with the Shires, operators, etc. to create a common agreement on what should happen next.

3.2.3 Government agencies/regulators

but along the way there’s a need for Fisheries, DEC and the Commonwealth people to be convinced that there’s a package here they need to support.

The people who could use the research would be everyone who has a hand in regulating human activity, from DEC to DPI, Shires, and councils.

could aggregate the research/information, then put it to an internal forum of DEC area specialists then let them decide what information is relevant to their areas of work and how they can use it. This would also create synergies between people at the forum. Invite people across DEC, not just marine. It would help build bridges between marine and terrestrial branches.

I think it would be really important to include the Shire and in particular the councillors so that even if they don’t use that information they have that education on what it’s about and the other side. Because they got a lot of the community sentiment whinging ‘I don’t want to pay a $30 fishing fee’, but they probably don’t get as much of ‘this is the rationale behind it’ in a layman’s terms.

The government departments are easy because you can list them and there’s a person, you can identify with them.

The power base has shifted so we are seeing what we do undermined and under attack by other people coming in with other ideas. So its going to be very interesting times ahead. But the power base is not with us. It’s shifted. So the conversations that Kelly needs to have, are with the Shire of Exmouth, or the GDC. Talk to [redacted] from Tourism WA. Ask him “how’s it going with you as an agency trying to develop a tourism product for WA?” Where’s your minister and his influence over this area now? Now that the area is under control by…”He’s under similar circumstances to us. It’s like their advice with regard to what is best for the tourism product, pffff!

The agencies are harder in some ways is because there is so much turnover – the people I’m talking to often change every 6 months – just as they start to get it they leave. We talk to these people until we hear a common theme, then we come up with a first set of questions ourselves and put them up as straw men. If you guess the right questions they get excited and give you a range of questions for the next iteration. Occasionally they take it the wrong way, then you have to mend bridges, but that’s not so often that you give up on the approach.

I’m very interested in the research and modelling. I’m very keen, and I know a lot of other staff are, to just get an understanding of how we can get that information, where does it come from.

I probably have relationships with three people in the Exmouth DEC office. My take home message as a scientist is DO engage with people. You could organize workshops, or retreats, etc

A 5 minute conversation with a very senior person in a Government organisation is worth more than 12 months of ‘consulting process’.

You should also talk to people in the Marine Policy and Planning Group: [redacted] And to [redacted] from Fisheries, and the regional Fisheries manager for the Ningaloo region.
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- Keith Woodward, manager of our Shire engineering services, is good to talk to regarding road maintenance and the bin scenario and the cost of those services. His staff runs all that and he has spreadsheets with all the hours and costs.

- Speak with the Shire CEO, community engagement manager and environmental health manager.

- The more appropriate person to talk to might be [Redacted] who's manager of the Shire’s finance section/corporate services, because I think a lot of that stuff related to the models is sort of finance related.

- Talk to [Redacted] with the GDC, [Redacted] with the NSDC, and WAPC.

- Definitely [Fisheries] policy people, the head of the recreational fishing program. The only way that things can get changed is by the Fisheries Department hearing from people.

### 3.2.4 Indigenous groups

- And you’d have to include the indigenous mobs.

- Get some Baiyungu people together and talk to them, informally around a table over a cup of tea. Sit down and have a comfortable talk. When people are comfortable, they absorb information better.

### 3.2.5 Locals/community

- I think we have to ask the community to pose questions for the model. It’s really into crunch time. It should have been happening all the way through. We need to ask them: how do you want to use this research, who needs to know, where does it get housed? This needs to be dealt with quickly, and should’ve been dealt with early on. Go to the community now and see what they want, see what happens, then re-evaluate and go from there.

- I don’t know if you can reach the redneck thinkers. A lot of them are older, so probably set in their ways and hard to change their opinion. It would be interesting to get together with that older part of the community. I don't know how you would, they all have their social networking things up here, or the fishing club or the RSL. They seem to have morning teas at the bowls clubs and stuff. You get a few of them that have been here for 40 years, they can tell you about the changes and you can find out where their heads are at.

- Locals might not all have political or environmental ideals that line up with ours, but if you can start engaging and feeding information back to them, they can get a greater appreciation for what’s happening in the area. Then we stand a greater chance of getting the sustainable outcome that we’re after.

- There’s still an opportunity to do something to reach out to the locals. We’ve got a year to do it in. We have to start now, and we have to put funds into it, because if there are no funds, there is no energy.

- But when you go to meetings about stuff for the community you find the same faces there all the time. There are people who are interested and want to have a say. You see them time and time again.

- The 'sexy' parts of the research - turtles, whale sharks, manta rays, the inter-linking between the fresh water aquifers in the region etc. - would be of use to the community and the corporate sector.

### 3.2.6 Pastoralists

- There are pastoralists they’re adjacent to the Marine Park when you go down to the south. That would be a major achievement, to get them on side. The guy from Gnaraloo sent someone up to the Symposium so those two southern stations have certainly shown an interest.

- [How about getting info out in a forum] In my experience it’s quite difficult because the Ningaloo pastoralists are always under work and resource pressure. So it’s difficult to get them to come in for meetings. You’re going to get 1 out of 5 or 2 out of 4. I don’t know if the resources are available for this, but it would be good if someone like you prepared something and disseminated it. It doesn’t have to be a forum that takes a whole day, it could just be something like ‘This is what was found, here’s a booklet on it and we’d really like you to be involved’. I’ve been very surprised at how willing the Ningaloo pastoralists
are to go through paperwork, government documents and reports. They read every page. In my experience, the reason there are reactions to Government documents and reports at times are because they find out a day before a review period closes (a week thereafter or not at all!) of a particular important draft Government document or report influencing future direction, land use and practices on the ground. Or they’re simply told after the fact “Here’s the model / outcome and how it’s going to be from now”.

- [And you think that's as simple as just sending someone out with summaries of the research, go out to the stations, talk to...] Send someone out who has a clue. Do not send out a graduate. Think of the land holders and managers - they’re flooded with researchers and give up their time again and again to support the research. For no return. In the long run, this affects the willingness to support research efforts. It is just expected and assumed that land holders and managers will give up their time, again and again. At least have the courtesy to send an experienced representative with some seniority, so that there is a possibility of return for the time provided by land holders and managers.

- Yes. I reckon in terms of questions [for the models], I think it’s very important that that you do interviews with the five pastoralists.

3.2.7 Tourism operators

- Yeah, you could try personal invitations, there are certainly some key players. You could try inviting particular stakeholders. You’ve got the tourism industry; you’ve got all different groups.

- The operators on the ground are really keen and willing to talk to you, as long as your willing to go to them (at the pub, on their boat, etc.), and you can get good engagement if you’re open and honest and persistent, and not perceived as just another researcher who blows through.

- Ideas for presenting the research? It depends who you’re trying to target. If you’re trying to target commercial tour operators or tour operators, I think trying to generate stewardship with them would probably work, like ‘you can have a say in the future of ecotourism in Ningaloo’ and ‘find out how research can benefit your business’, or ‘this is going to be a great thing for you guys and you can have input into it’. That’s probably going to work for local operators.

- There is one whale shark business that I think does reasonable interpretation, but for the rest of them I think is all pretty much a non-event, but I mean there’s no harm in getting the research out there and then leaving it with them.

- March is the beginning, just before the whale shark season starts. A lot of whale shark operators aren’t even here. They don’t turn up until the last week in March and then it’s full on whale shark season, so the last thing on their minds is to sit down with a researcher and spend 2 or 3 hours sitting down having a chat. A lot of them will just say no, I'm not interested. Whereas towards the end of the season, July time, but not during the school holidays, July time is probably the best time. Because at the end of July they’re still here, they haven’t left yet.

- [in terms of, getting people out to a workshop or a presentation] You’re flogging a dead horse. Operators won’t go to some kind of information talk if it’s just going to be scientifically based.

- [What if it's the modelling stuff based around tourism numbers, impacts, things like that? That would interest them?] Yep, always point it back to how this is going to help their business. And then they will come. I’m on the Visitor Centre committee. We can send emails out to all the members of the Visitors Centre, but unless it pertains to their business they’re not going to come. It should start off with how this will help you. These are the benefits, this will help you, boom, boom, boom, talk on Friday night, 6 o’clock, bang!

- More operators in the region should also be contacted.

- And I guess you’re going to talk to the whale shark operators? And the glass-bottomed boat round at Tantabiddi. Because I think he’d be interested, because he’s out there every day looking at fish and looking at the Reef.
3.2.8 Business
- The Chamber of Commerce of course, you’d have to include them
- [Do you think the Chamber of Commerce would be interested in maybe seeing some of these model runs?] Not everyone in the Chamber has the capacity to interpret or absorb or take information in as it’s supposed to be. So it all depends on who the Executive is at the time as to whether they have the capacity and capability to get involved in the intellectual process. If the Chamber had access to some of the significant models, particularly for the impacts of growth, I think there would be an interest.
- Yeah, the smarter businesses would be interested in the model. You’ve got to remember, you’ve come to the most backward town in the whole of Australia.
- And the thing is, down in Perth, these seminars would be full. But the problem here is, people here don’t see the benefit of those seminars because they’re uneducated, basically most of the people here have been handed businesses from their fathers, you know, they’ve got no university degrees, they don’t have a clue. So when the Small Business Development Centre comes in and does retail training, I’ll send three/four of my staff to that, we’ll be the only ones there. who else is here? Nobody. Unless you get businesses sending their people to these courses then the town’s going to stay the same, there’s not going to be an improvement.
- If you want input through the 3 different organisations then have 3 separate seminars, because then it’s easier to manage but then. The Chamber of Commerce will be asking different questions from the operators.
- You should speak with [name] with the Chamber of Commerce.

3.2.9 NRC working group
- We have a NRC working group which is an incorporated body. The GDC has been strongly involved, via [name], as has [name] with Curtin University. The chair is [name] who is also the head of the Exmouth Chamber of Commerce. The previous chair was the [name]. NRC meet regularly on an as needed basis, often incorporating tele or video conferencing.
- With the NSDC closing down and the new regional planning committee not yet started or resourced, the NCC and WAMSI could work through the NRC working group to help with the Knowledge Transfer Framework. The working group has diverse local membership, and although pastoralists aren’t represented there could be scope to include them. NCC and WAMSI could sit down with the NRC working group as a starting point for ideas on how to best to transfer the research to the local community.

3.2.10 Cape Conservation Group
- People know what the CCG do, whereas I wouldn’t have a clue at this stage of the game, and maybe there are lots of people in town who don’t care, but certainly I think people in the Cape Conservation Group and lots of people in the community do care and would like to know a bit more about what the Ningaloo Research Program is doing.
- The Cape Conservation Group obviously would be very, very interested in the models—because I think then you’ve got a lot more basis for saying, ‘Look, here’s this model and it’s saying what we think’ because sometimes I think that people think we’re just operating from an emotional standpoint. And ok, models are also limited, they can have mistakes and they may not have a particular variable built into them, but they should try and build in as many variables as possible. But I think to sway a lot of people, you know, if people don’t want to believe in them, they’re not going to believe in them anyway.
- All the research is really interesting. The Cape Conservation Group is probably going to be more interested in the slightly more charismatic stuff, more of the animal/fauna stuff than, rather than say sedimentology. Hydrology is really interesting as well, with the whole coral system up here. But it’s all interesting isn’t it? And anything to do with use, like the work on coastal camping, is going to be really interesting.
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3.2.11 Coral Coast Parks Advisory Committee
- The Coral Coast Parks Advisory Committee which is a DEC community advisory committee that has input into the National Park and the Marine Park operational plan. So that’s where research like that can be used.
- I think the local interest in the models would be the Coral Coast Parks Advisory Committee because, I mean, they’re all people, stakeholders who are part of the community.

3.2.12 Recreational fishers
- What’s the fishery mob called? They’re very proactive up here. Is it Rec Fish West? I think they’ve had a huge turnaround in the last few years in the way they view bag limits and sanctuary zones. They’re more accepting of ‘we don’t fish to fish completely’ and there’s a lot more people that tag-and-release. That’s just my personal viewpoint on that. I can’t back that up.
- Have you spoken to anybody in the Exmouth Game Fishing Club?
- [Who would be interested in coming together to see the modelling and research in relation to fish?] Probably I would say your charter operators, your commercial fishermen and general public. Probably station owners and the businesses in town, too because if there’s no fishing then the tavern, shops and restaurants, they obviously receive fresh fish from the local fishers.

3.2.13 Commercial fishers
- You should catch up with Kailis. Kailis has spent millions on doing their own research on the impact of the Straits proposal on their fishery. And it’s local as well, local industry and one of the biggest local industries, actually if not the biggest, apart from tourism.

3.2.14 Accommodation providers
- You should talk to the caravan park owners, Potshot, Novotel and Sal Salis.

3.2.15 Schools
- And the school – have you got the school down?
- I would like to know if there’s an opportunity for any of my students to be involved. I think that’s also very important. And as the science teacher at the school I would like access to some of these scientists, and for them to make themselves available to come and talk to the kids at the school. I think that’s important as well.
- [Susie Bedford], she’s a teacher at the school, a high school teacher. I think her original degree was in marine biology so she’d be a good person.

3.2.16 Cape Board Riders
- There’s also the Cape Board Riders Association. They’ve got a strong membership.

3.2.17 Industry/consultants
- I guess other potential stakeholders will be consultants who are doing reports for development proposals, the EPA who’s been doing assessments on management plans for development proposals. Industry potentially, but I guess they would be doing most of that via consultants but not necessarily always.

3.2.18 Ningaloo Turtle Program
- The turtle interpretive centre is another entity which would be interested in some of the research.

3.2.19 Scientific community
- Additional stakeholders could include the international scientific community, such as the International Society for Reef Studies.
3.3 Use networks

- We need to look at where the network nodes are currently strong, which our works shows to be the GDC and the NSDO (the NSDO office closing is going to leave a hole in the whole thing). We need to use these people to help us get buy in.

- We need to look at entire network (using our network map), make sure we know who the important people are, prepare some simple summarised material explaining the implications of the research done so far, then start informal personal conversations with these people about the issues involved in leaving something behind to ensure the research is used. We need some champions making decisions in government – this will be the hardest part.

- We should work our networks and go around and say hi, I'm from the NIngaloo Cluster, here's what we've doe, here's what we're worried about, just wanted to keep you in the loop, we'll let you know as things come out - start establishing personal relationships. But the problem is many of our networks are almost purely science, and the cluster managers are so busy how can they get another network going?

- is the only one with a decent network in the region. He has the most potential among the researchers to help with research uptake, but he’s probably going to step back a bit. It worries me because his presence and ’s are very important. We really have to use those other nodes or create some new ones. The tenuous link between universities we have at the moment will be even more tenuous without .

- It’s a wonderful, well managed group of researchers, but apart from I’m not sure that we’ve got the vital links to actually translate the research properly –this means we’ve got a problem.

- ’s role has to be recreated by someone, and it may be that he has somebody in mind, like , who’s young and genuinely cares about the area, but lacks the clout has. This is vulnerability – that ’s conversations won’t be had if he steps back. The only saving grace is the new cluster and the negotiations for that might be a conduit if we show success in this Ningaloo project.

3.4 Find champions for research

- If the researchers don’t have any champions for their cause… that’s what they don’t seem to understand. Then someone like [a politician] comes up and says what a waste of time, because the pastoralists aren’t brought in as an owner of it. If you speak to the people in the community and say ‘look, it’s more important to spend $5 million research rather than on something else,’ but no one knows about it, they just say ‘what research? It’s all crap.’ Then when suddenly something really, really important comes up, and the researchers know, but they haven’t got champions because they haven’t got supporters on board. Look at the Save Ningaloo group. They made people aware – and they had totally no idea of what they’re talking about –but because they convinced them and made them aware, they had 10,000 people marching through the streets saying let’s save Ningaloo.

- Researchers haven’t cottoned on to that. Get a champion. 10,000 champions. The government gives you money. That’s where the $5 million came out of, was because there were so many people saying you can’t do this, so the government said alright, we’ll bail on the whole plan. There’s been no research done so we’ll give $5 million for it. They couldn’t make the Maud’s Landing decision on any quality information, they couldn’t say this was going to hurt or be good. And I’ve got to admit that the research would have showed that that was the spot to put it. So if the developers were smart, they would have got some research done and it would have shown that was the spot to put it. It works on both sides of the coin.

- If you’re trying to drive the release of the research results at a community level rather than have people organise it from Perth, you’ve just got to find the right person. General community apathy is fairly high. But if there’s somebody here that's a champion that wants to drive it, then they’ll do the job.

- I still believe things can be fixed. I still think one man can make a big difference – especially when there’s a few of these ‘one men’ working together with a vision of ‘we care about our environment’. And I have not met one person on any side of the debate that doesn’t care about that. They just act on the best information that they have – even
the recreational fishermen. That’s their feeling, their understanding. So whose fault is it that they’re not acting differently? Yours and mine because we’re not doing our jobs right.

- We need some champions making decisions in government – this will be the hardest part.
- We need to find champions both in government and the community.

### 3.5 Use knowledge brokers/liaisons

- It will be helpful to have people with a foot in the science camp and a foot in management camp facilitating this; people who know and can make the connections between different fields. E.g. oil spill response is something oceanographers would know about, but what they might not know is that in rec and tourism planning this research is really useful for placing dive trails. Likewise, the rec and tourism planners wouldn’t necessarily understand the importance of oceanography to their work unless we point it out to them. For example Turquoise Bay has had 3 or 4 fatalities. It’s clearly not the best spot for a dive trail. It was put there because people were already going there, parking on the vegetation. So they created a car park, then more people came, then a dive trail materialized by default, which is actually not the best position because it can be quite dangerous in certain conditions. If they had proactively planned dive trails for Ningaloo, oceanographers would have been asked what areas and under what conditions are parts of the lagoon at Ningaloo unsafe for water sports. This is how we’ll be brokering the knowledge transfer process.

- I think the scientists live in a scientific world because that’s the nature of the beast, I live in the tourism world – it’s the same thing, you focus on what you’re doing. So they need to probably have someone who’s more of a community liaison sort of person that’s not of scientific research based to work with the community.

### 3.6 Be respectful/professional

- Communication is an art and not a science, and it needs someone who is skilled in many disciplines, including psychology, communication, language, tone, confidentiality, professionalism. I’ve never had an issue with some of the most difficult personalities on the reef but I’ve always approached landholders with respect, courtesy and due regard to their on-ground knowledge and years of experience. I’ve still told them hard things they didn’t want to hear, but to my surprise they reply with ‘Well, that’s not what we think, but fair enough comment. Over time working and credible relationships are formed that based on trust and mutual respect.

- Most researchers are happy to talk to people. They should remember that they are standing on someone else’s home town. They should maybe make their work relevant to the guys on the ground, who really are trying understand what we’ve done. If they’re not seen as arrogant assholes blind to the system they’ll be more successful when they start feeding back the information.

### 3.7 Have two-way exchange

- There could also potentially be an opportunity to have a two way thing where the community could present the scientists their side. It could be an all encompassing thing rather than just science, science, science.

- [Do you think any of these stakeholders would have anything of value to contribute to the researchers?] Yes, you’re preaching to the converted – however, the focus of my work has been mostly with other researchers.
4 Communicating research results

4.1 Improving communication

4.1.1 Get research results out

- I think how you said it was right [that research results should be available to everyone]. It should be available. So people can say, well, I’m not interested in that but let me read a bit about this.

- Yes, we’re very interested in getting all the valuable scientific data we can, and we’re very interested in making sure that the place is managed properly. Very interested in making sure this place is managed properly.

- is a critical player in all this. She is even more important than in terms of the number of people she knows, her knowledge of where people need to go to, and how to express things.

- So I would like to see a mechanism or a pathway to getting that information. Don’t underestimate people’s intelligence. People are not stupid. It’s not that they can’t understand the research, it doesn’t have to be dumbed down. It doesn’t have to be ‘an eco system is important because...’ Let’s challenge them. Let’s build capacity and say ‘the reason the Ningaloo reef is a lung is because it does this’. They’d be fascinated with research such as the shark tagging program with more information on the movements and habits of resident sharks.

- The worst thing that can happen is a castle or fortress full of information in Perth or in a library in Exmouth. It needs to be sent out onto the ground.

- Some researchers are saying their data isn’t ready - we can’t wait, it will be too late. We need to gather what they have, help them glue it together, and then put things together ourselves. This is in addition to the MSE modelling that is doing. There are stand alone results of the research (i.e. not just the model outputs) that are of interest to people in the region.

- I’m very keen to push ahead on preparing for getting materials together to get the research out there. We need to get preliminary findings from researchers, put clusters of research together, then write it up.

- The people on the ground are desperate to get information feedback – they want to know what they’re getting out of all these researchers trooping through. We can’t wait for the models, we need to start getting the one pagers out on different bits of research.

- The key point is do not do it from Perth, you’ve got to divulge it down to the region, but that’s not enough, down on to the ground. What is the point of this research? I’m afraid it just seems to be academic and a lot of PhD qualifications, that’s all it is. It is practically useless unless it is disseminated down to the people on the ground. Even if it you have to make it part of someone’s PhD qualification, so that they’ll do it well. If this is done well, we’ll actually get results on the ground. Here’s the thing, the guys on the ground are all about results on the ground. They’re faced with an issue in the morning, they decide what to do about it by the afternoon, and late afternoon it’s done.

- If everybody knew that the whole area’s bathymetry had been mapped on 50 metre transects, or whatever, I’m sure a lot of the locals would be more enthusiastic and knowledgeable about the area. It’s the dissemination of that information and how you make it available.

- Accessing that research is a big thing for us. We are genuinely interested. We think we know things from our own observations and on-ground experience, but at the same time being able to understand and know how to use the research would be so beneficial. It’s knowing how to use it, how to access it. How do we pull out parts that we feel are relevant to what we’re about to plan?

- I’m very interested in the research and modelling. I’m very keen, and I know a lot of other staff are, to just get an understanding of how we can get that information, where does it come from.
4.1.2  Develop communications plan

- When you talk about researchers wanting to get the message out there, I suppose the other thing is ‘what is the message’? Why are they doing it? Are they just wanting to do it because it’s important for people to know what is being done? Are they doing it (communicating) because they have to? Why do they want the public to know? Why isn’t it just insular? Why do people here need to know what you found about the tailor fish, etc. They’ve got to be clear about what they’re trying to do.

- I think that would be good [to have a communications plan for the research project]. You’re really implementing one.

- This needs our energy now – and the cluster three leaders are very busy. We need to mobilize the Kelly’s and communications people in CSIRO etc. to help us. We need think systematically about who we need to talk to. We need to understand what resources we’ve got with [ ], how much we can do with those resources and where the shortfall is going to be.

- You should talk to [ ] about his thoughts on communicating research and how their project could play a role in this. We need to think about how we can help [ ] address bigger strategic communication issues. Perhaps we need to bring together a group of people to talk about the communication issue. These conversations need to happen with lots of different people.

4.1.3  Focus on communication not information

- You really need to go beyond getting information out and focus on communication [communication ensures the other party has received the information, then processed and understood it]. We’re struggling with communicating our results in a way that people can actually understand and take away with them.

- If we’re really serious about getting the information out there in a way that’s communicating the information as opposed to just getting it out there, we need to start by asking locals what they want to know and how they want to know it. I may even change around our timetable to fit this in - if we run individual meetings with different groups before we run the stakeholder workshop it will help us really understand where people are coming from and what they want to know about. They could also help us refine how we present our work at the workshop.

- We met with a Professor of education in cognitive psychology, who brought home very strongly that you’ve got to meet people from where they’re at with this kind of stuff. You have to understand what they want to know and where they’re coming from and then start from there. Which is actually quite difficult when you’ve got a model that’s spitting out complicated results - how do you bring it to their level?

4.1.4  Coordinate/partner with other agencies

4.1.4.1  Partner with GDC

- We have some marketing/promotional expertise within our organisation. We’re not that big, as you can appreciate, 12/13 staff, but there is some expertise in promotion and that sort of thing. And yeah we could be perhaps play some sort of role in this, maybe jointly convene it. We wouldn’t be a bad partner. We’re here in the region. We’re hoping to play a part with the unis.

- Perhaps we could be a part of convening a meeting or promoting a meeting or whatever. We can put stuff [relating to research results] on our website, etc. You can have a look at our website, we’ve just upgraded it and it’s got a lot of information on it. Or even a link through to the right site.

4.1.4.2  Coordinate with DEC

- DEC has got a little bit of a library out at Milyering but it’s a long way away and so it’s not really accessible to the public.

- DEC have talks once a week, over whale shark season. Anyone can go along and learn about the sharks that they’re going out to swim with.
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- People like [redacted], I see their role as mediating between WAMSI, the people giving us the money and the researchers. I think they already have a communications person doing that in part, and what I've seen them produce is good (website etc.), I'm just unaware of the full extent of their plan.

4.1.5 **Educate scientists to be better communicators**

- Educating scientists in how to be better communicators is key - so they don't bore people to death with fine details. It means as a scientist you have to grow and appreciate that people really don't care about some of the really fine technical details – you need to be able to define the big picture and explain it simply. It also helps you as a scientist. Einstein said: if you can't explain it simply, you don't understand it.

- When I have to give a new talk to a new audience on a new topic, I actually practice it in front of my kids. My youngest is 7. If they can't feed back to you, in their own words, a reasonable facsimile of the message you're trying to get across, you have to change what you're saying.

4.1.6 **Use a mediator to help scientists communicate**

- There should be an expectation for us to communicate with the general public, but it would be useful if there was a mediator to help facilitate this, via arranging radio interviews, presentations, etc. Otherwise, I would really have to go out of my way to find the communication channels and this isn’t my area of expertise. Even though I have a personal interest in science communication, I’m so busy when I go to Ningaloo I don’t make the time, and I don’t even know where to start. But I would be happy to do something if I was asked or if it was arranged by someone else.

- Scientists have a lot to learn in terms of communicating our research to the general public. If there was a mediator, this is a person we could learn lots from. Imagine if there was someone coordinating this, for example a science story every fortnight in the local newspaper, and they would choose science teams to provide a stories for the year. They could also subedit our texts for a general audience. The scientists could learn from them, they would get better at writing for general audiences - capacity building for scientists to be communicators. We’re trained to communicate in the exact opposite way to what is required for a newspaper, so it doesn’t come naturally.

4.1.7 **Have a ‘no surprises’ policy for government and locals**

- When you present these kinds of things, you have a ‘no surprises’ policy with the departments so they get a heads up about what you’re going to say and are prepared. Equally, if you have an unpalatable message for the locals and local government, you better do some careful groundwork to ensure you bring people along to reach the same conclusion as you do. Otherwise they’ll just write you off and not want anything to do with it.

4.2 **Formatting research results**

4.2.1 **Use formats that meet stakeholder needs**

- We need to find out what research the people in Ningaloo need and in what form.

- Ensuring that uptake will happen requires us to deliver our research to the recipients in a way that they can understand it and use it. We should be delivering high quality research that has its own legs – it should definitely outlive us, and live without us.

- This means good research journal articles that talk to other scientists (measure of research quality), as well as reports that meet the clients’ needs and answer their questions in a way they can understand.

- We’ve been trying to understand how people perceive research and information to see if we can better formulate it so they can take it in, but ultimately we’re relying on a method of doing science that comes out with a written document. We’re limited to the written medium, although the interactive models provide an alternative that is especially being explored in the Ningaloo work.
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o [In terms of formats for research results]… it’s pretty easy to read it in a chart compared to tables, with percentages and figures, especially if you’re looking at a lot of data and just want an overview.

o In Ningaloo, more than any other project I’ve worked with, the stakeholders (operators, business people, etc.) deserve some sort of information delivery that suits their needs. This requires, I think, presentations that can be delivered to the public to meet their needs. Something that doesn’t give them information overload. We were scientists talking to scientists last week [at the Ningaloo Symposium], and I found it hard to stay attentive through all of the presentation over the entire week, so I would imagine that it would be hard for the public to take that in too. We need to come up with some very clear messages about what we found out that’s tailored to the level of detail useful to the public – but certainly not dumbing it down either.

o [How do you know what suits their needs?]. At the moment I’d be guessing as to what the public wants to know from the research. [So how do you find out what they want and how they want it?] Some of it would be contained in planning commissions, and relevant to local planning issues. In our meetings in Coral Bay we talked to operators and hotel owners, casual conversations, and we got a sense of their concerns – we took notes on that and we could probably develop a pitch based on that. Most of it has to do with sustainability and the needs of the community. [Do you think there’s space for asking stakeholders about what they want?]. Yeah, I don’t see anything wrong with that, I don’t see a barrier there.

4.2.2 Use simple language

o The research results should be provided in simple terms, summarised simple terms.

o We need to convince the scientists that putting their work in a simple format isn’t demeaning them, it’s actually helping them have influence.

o We need a simple explanation of the MSE model and an example of what it can do. You need to find a way of drawing the questions of the community so the scientists can produce answers.

o The scientists need to communicate the research results in layperson’s terms.

o A summary of the research would be fine for the scientific community, but how does Joe Blogs, the guy that comes to the supermarket and does the shopping, and who thinks ‘I wonder what effects my fishing is having on the area’, where is he going to pick that sort of information up? You need to go back to a basic style of writing to actually put the information out there if it’s available.

o KISS, keep it simple when you’re putting the research results together. If you don’t you will go over the heads of people, and they won’t take notice of most of your work. Maybe 40% will get some sort of hearing, but what about the rest?

o To get some sort of result from these research programs the information has to be put in a form that the general public can understand

4.2.3 Organise under easy-to-use themes/subjects

o Organising the research under themes, into sections or something would work. I’d use that myself, I suppose, because when I’m looking at different issues in the park, I’d just go to that area. There is no point in not having $30 million worth of research and modelling at our fingertips. And you would use it. You would definitely use it. I would.

o The researchers really need to get together and channel what they’re doing into subject packages (e.g. socio-economic package).

o Can the research be broken down into user friendly basic language? An online thing? I look at some documents and I just go, oh my goodness, I’m not going to go there, where do I begin? I’m dealing with enough stuff as it is. I want quick answers. So if I want to look at moving a camping location to another site, I can actually just type something into a field and go to that research that, let’s say is working on.
I believe it would be used more by people on the ground operationally, the social, the parks and the business services side, not conservation. So guys like our senior rangers or a project officer, if it's in an easy-to-use type manual that's going to just say they have to develop a new campground. Somewhere easy for them to click onto that gives some historical background and what research has been done for this particular area. But it has to be user friendly. If it's just data it's not going to be used.

4.2.4 Focus on recommendations

At the Ningaloo Research Symposium every presentation followed that format of 'introduction, talking about their process, the methodology, here were the findings and then a brief conclusion, thanks very much.' Whereas I thought that the symposium could just be all about recommendations, you just have to get up and make your three recommendations, three. Shoot from the hip, now that you’ve done all your research, honestly, what would be your three recommendations? Just kind of force people to be a bit more honest and a bit less academic. To get up and say, all things told, having spent 18 months doing aerial surveys and having done this and that, I really recommend that we should, boom, boom and boom. At the end of the day, I think people up here probably just want to ‘what do you think, what do you recommend?’ As much as people want to talk about how much they’re interested in research, I think people often just want to be told what to do. Often people don’t want to hear three ideas they want to hear one idea, one good idea, whereas this is like hundreds of meandering ideas. Some people have done extraordinary detailed work but it’s still quite hard to know what they actually recommend.

Like at the end of [redacted]’s projects, I’d be so interested to know just what does she think really should be done? Having spent 3 years working in the area and what would be her top 3 tips for not f*cking the place up. In a way I think well, God, if we all just come up with our top 3 tips and circulated that in a kind of 5-page glossy brochure, it’d probably be quite powerful rather than a model, like, you know…It’s a good idea I think. I think simplicity is maybe the key for people in the region. As long as they know that the detail’s there if they want it, If people are really so genuinely concerned with research they can find out. As long as they know where the research is, I don’t think anyone here knows that really.

4.2.5 Tell a story

Unless we put the research together into something coherent that tells a story I don’t think the MSE model and other research applications will be picked up.

My presentations have become progressively simpler, and that’s been a tough process for me because I don’t like simplifying things too much I think you lose some of the richness, but NOW I recognize that you have to do it, it took me a long time to get to that point. We should ask people how they want modeling results presented to them. Feedback from the first workshop I held was that the information was too complicated – that it should be told like a story.

The research will work for some of the government people, but maybe you kind of need to market it with some real examples because modelling it’s so out there, it’s so hard to really explain it to people in terms that are interesting or even comprehensible. You need to make it really relevant, applicable: personal stories, personal situations, local scenarios. Maybe even contact the operators and say, we’re looking for examples of where this has happened in your whale shark tours. It’s going to have to be quite personal to engage people.

4.2.6 Consider “what’s in it for them”

To sell the research and models to people in the region, you need put things in terms of what’s in it for them. What are they going to get out of it? What benefits are there to their business, to their lifestyle to…yeah, I think honestly business and lifestyle are the two things that matter most to people up here. Business owners are busy; if they can’t see much in it for them they’re not going to engage with it.

We need hard nosed briefings with key “what’s in it for you” comments, and what’s going to happen if government is found to be derelict in its duty, but said nicely.
4.3 Communication channels

4.3.1 Face-to-face contact with people

- But I think that face-to-face is probably good, the researchers might find out useful information too. I had a chat with the guy that was doing the crayfish research, and I told him a friend of ours actually worked for the guy that was doing crayfish work in the early years. And he was like ‘oh really? I’d love to talk to him.’ Without meeting me, he would never have known about this guy or found out this information,

- So I think hard copy stuff is good and face-to-face stuff. As a society we’ve gone away from face-to-face stuff and I think people actually really crave it and need it, and need to feel interactive. Everyone’s sick of being a number or a reference number on hold. I really think getting into the community and talking about the findings and then obviously being capable of standing there, if some of the community are in disagreement. It’s going to have to be ‘wear your armour’ because there might not be people that agree with what’s being said.

- To get the research results out to people in the region, you need to go beyond just handing out material, like fact sheets, etc., you actually need to talk to the people yourselves.

- A central system and face to face contact in specially organized forums are suggestions.

- I would also suggest direct contact with the town planners at the Shire of Carnarvon, Shire of Exmouth as well as the GDC.

- We need to get out there and talk to people at a level that they can be engaged with, and we should highlight key things from the research in conversation, rather than just give people the summary documents.

- Get some Baiyungu people together and talk to them, informally around a table over a cup of tea. Sit down and have a comfortable talk. When people are comfortable, they absorb information better.

- [what’s the best way to get the research to people here? – do they want to talk to the researchers face-to-face, do you guys want a workshop?]
  - I think initially that would be a really good thing because that way you’ve got a face to go with the name. These research permits come in and a lot of them you see are under the same names, so yes, to get that relationship set up I think would be really good. And if there are specifics that either end wants clarification on, then yeah, potentially a workshop I think would be a really good way to go. It’s just getting everyone together at the same time I think is going to be the difficult thing. The summer months is our quieter period so that would probably, as far as we’re concerned, work better because we have the timing and attention of the staff to be able to work in with that.

- Potentially you may find it would be beneficial for a range of staff to sit them down as a group. Because my understanding is there hasn’t been a lot of staff involvement apart from OK, yes, we know these people are out there and if you’re out there go and say hello to them and see how they’re going and that kind of thing. But we’re starting to get some monitoring programs happening. There have been some researchers that have come up that we’ve had the opportunity to get out with and assist in some stuff. But yeah, they’re the staff that primarily are on the ground, doing the enforcement side of things. I think it would be valuable to get their perspective on how they see things.

4.3.2 Presentations/forums

4.3.2.1 General

- Once we get a product that’s fairly finished, we need to take it out on a road show, and pitch it at different audiences with different levels of detail. Go to them.

- Also, there have been presentations in Coral Bay, so they’ve been fair in that, but it’s probably quite a small group that would be exposed to this.

- [Do you think there would be merit in doing something like a Ningaloo Symposium but specifically targeting locals and local audiences?]
  - Oh yeah. I think it’d be great to have that. And it really does need to
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be targeted at the locals quite clearly in the way it’s promoted and the way it’s advertised in the paper and on the radio. So really ‘learn about your region’ and ‘we’re learning more about the region to improve it, make it environmentally more secure, to more clearly understand the development opportunities and to understand how many tourists we can get’ and all that sort of thing. It’s got to capture the imagination in the way it’s presented. And I think if you did that, well probably you’d get a pretty good turnout.

- Host another forum targeted at locals, outside the peak tourism season.
- We’re always really interested as a group, just as a general public education thing to have the researchers present. I had one or two who presented to general public, organised through DEC, but the limitation there is that they don’t have results. They’re sort of part way through, they haven’t finished or it’s inconclusive or things like that. But definitely public education is one of the things we’d look at.
- [Would having a small group of the scientists come up and present the highlights of the research program be of interest to the locals in the area?] I think if it was in layman’s terms it would be. There’s certainly a lot of people interested.
- I think getting the information out that there is a presentation on, is for starters often the biggest trouble in Exmouth – people don’t know the things going on. So you’ve got your noticeboards and most people read the Northern Guardian, which seems to be the number one form of communication to get the actual message out there. That’s probably the biggest hurdle is letting people know about the event and I guess as long as it’s not full of jargon, short snippets of interesting information... There is also a new community email service which is great to find out what’s happening around town.
- The sort of presentations did for the Ningaloo Symposium is not going to interest a lot of people, but there are snippets from that which certainly would be, like ‘oh, you know, they tagged this shark and...’
- We had talked about getting a road show together with 3-5 rather than the full suite of scientists. It could go to Coral Bay, Exmouth and Carnarvon with a couple of brief presentations and one page summaries on the projects. It should provide a forum for discussion rather than being information overload.
- I think the Chamber of Commerce and the commercial sector, the tourism operators, should be interested [in a public presentation of the research results]. If they want to start targeting their marketing where they need to, they should be interested. Again, the one page summaries and building up to it will start letting people know what’s going on and what’s coming. Once the summary sheets are out, whatever interest is generated will be a good gauge as to what level of presentation you do.
- Forums should be set up that focus on management directions and how they might be implemented, rather than methodologies, techniques and data.
- Researchers could also host additional forums with other people such as operators, pastoralists, recreational fishers, Fisheries, Tourism, local government etc. Have more than one forum, like [name] has done: he has taught us as his project has progressed.
- Long term engagement processes are good. Frameworks need to be set up for this to happen – maybe annual or biannual forums.
- I also think it’s nice to find out not only the research that they’re going to do but maybe get some follow-up, even if it’s in the form of talks.
- I knew when Ross Babcock’s come here, and he’s given talks, they’ve been really, really informative and they’re aimed at the general public. And ok, the whole town doesn’t turn out, but he’s always had a fairly good turnout for a town this size. I think he’s well received, because people go, well, look, he’s actually making an effort to talk to us and tell us what’s happening.
- [What do you think of having an event to showcase the research?] We’ve tried to do a lot of that sort of stuff through Cape Conservation Group, and maybe because its us, but the interest is almost negligible in that sort of thing. Now the first public workshop up here for the Tourism Destination model was really well attended. I don’t know what the follow up ones have been like. But that might be a bit of a gauge in what the interest you’d get. I think as soon as you mention the word research a lot of ordinary people just go
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ah, nup, boring, dry, not interested. So you’d have to try and present it in quite a creative, lateral, dynamic way I think.

- You wouldn’t necessarily need to engage people through a community event where they come along to the Town Hall and see all these flashy images, although that would be fantastic and I am sure if you provided alcohol you would get a lot of people there.

- I reckon a public forum and if you advertised it, I suppose, something like that through the Chamber of Commerce, through your Visitors Centre, through your Cape Conservation Group, any community-orientated groups you know, you’ve got Cape Boardriders Club, you know, the surfers, so you’re hitting all those different angles of the community. Even the SES. Just invite everyone along. Some people won’t turn up, those who are interested will, but at least if you’ve done it – even if you only had 10 people turn up. You cannot be accused of not trying.

- I think the expense of having the last one was probably pretty huge, you probably don’t need as big a conference as that. Maybe just have someone that is able to present their findings and talk about them a bit too. You could even probably see if you could get a hotel here to sponsor the event by donating the conference facilities to support research in the area, and you can have ways of bringing down the costs of things too.

- Pastoralists and businesses would like to have something more formal like a forum presenting the research results.

- Get leverage from the researchers going up to Ningaloo by having them arrive a couple of days early to give presentations, etc. particularly the more outgoing personalities.

4.3.2.2 Ningaloo Symposium

- We should also think about holding another Ningaloo ‘symposium’ that specifically targets locals [where there would be opportunity not just to see results presented in a digestible format, but also an opportunity to speak with and maybe establish relationships with the researchers].

- The symposium was good. What impressed me was the wide range of topics. What I got out of it is how much we don’t know – I was actually shocked at how little the scientists know.

- I was surprised at how valuable and applicable the research presented at the Ningaloo Research Symposium in Exmouth was to the day-to-day issues we face.

- For me, the findings about the impacts from recreational fishing [vs commercial fishing] were an eye opener. I knew there was recreational fishing pressure but until I went to the symposium I was not aware of the full extent of it. And that’s me, an environmental professional whose job it is to know, who was not well informed about this issue! How would the average person then know or be aware of the pressure that recreational fishing in Ningaloo is exerting on fishing stocks?

- I didn’t think a single presentation was too technical or too complicated to understand for the normal man on the street. I would just present the guts of the research (to be practical): ‘This is what was found’.

- There’s so much interesting stuff in the Symposium proceedings, some is over my head. Some I think, oh yes, we could incorporate that information into what we’re doing. But there’s obviously a hell of a lot more that we need to really know.

- I do think some other people’s work has been quite nice, [insert names] and [insert names] they did some really great stuff that they showed at the Research Symposium and some of it was just beautifully illustrated, like how they looked at the number of people at the Coral Bay boat ramp through the day. It was just this cool graph of the number of car trailers that are there throughout the day, a really nifty series of graphs that were very simple. The kind of thing where if you were with the Shire president, you might find some of that stuff useful, if it was presented in a really simple kind of way...but they’re not about complex relationships like the model, they’re fairly simple like two factors, x and y, time verses number of boats. It’s not a sophisticated kind of interplay, the things are in a kind of format that people can understand and seemed like rice, clear research.
4.3.2.3 Tourism Futures forums

- Had a very positive interaction with [redacted] and his project. The forums he put together with stakeholders – the meetings he had in the beginning with all of the Exmouth community – were fantastic get together meetings. The one on one relationship I’ve had with him has been very good, and I’ve been able to get good/relevant up to date information from him. [redacted]’s work was fantastic, getting everyone together in Exmouth.

4.3.2.4 Forum between DEC and researchers

- A middle manager forum would be a good way to go, to set up some good communication channels between researchers and key components of DEC (e.g. DE C managers and project/scientific officers, senior ecologists, and marine science and nature conservation people, for the region and the district). For Ningaloo specifically, you would want researchers to be communicating with the Regional Manager, the regional PVS and nature conservation persons, as well as district people. This should have been done at the beginning.

- If you’re going to put together this forum for DEC, it needs to be a concise presentation of what has been produced, how it can be used and where to next. Not presentations - it should be carefully structured, with some sort of research summary aggregating the information produced and presented by the manager of the research collaboration, then focus on issues and outcomes. It should be something managers can address in a day or half a day.

- Set it up as a review of the NCC, then ask managers: how are you guys going to use this? And what else can research be involved with? Thinking about how the research could possibly be used will trigger who from DEC should be at that forum.

4.3.3 Research summaries

- I think one page summaries on the research would be of interest because I don’t think anyone has much of an idea about what is going on out there. I think people would be amazed to know what exactly is going on with research.

- I think a page with a couple of paragraphs on each project, what it aims to achieve and what they’re doing. And contact details at the bottom of each of them so if someone’s interested in finding out more they can, or a link to a website to find out more if they’re interested.

- Again, the one page summaries and building up to it will start letting people know what’s going on and what’s coming. Once the summary sheets are out, whatever interest is generated will be a good gauge as to what level of presentation you do.

- A summary of the results of all the research projects put together needs to be no more than four pages. Otherwise managers won’t have time to go through it.

- We’re going to ask all the researchers for a one pager on their work, but what will happen is we’ll get it from some, but not from others, so we have to make it super easy.

- We’ll try and facilitate the transfer of as much research as possible over the next two years while the scientists are actively engaged. It will then be up to us to use the researchers’ synthesis contributions in their summary reports to continue digging down and transferring the knowledge directly to our recipients.

- Agencies need brief summaries of where the research is at and what affect it might have on their management or planning of operations. The management committee is thinking about putting together a one pager for the overall cluster outlining significant results so far. It might also ask each of the projects to do the same.

- Just summaries, with the intent of the research, the process possibly, and the conclusion, in a one-page format. So if someone is genuinely interested in the movement of fish through the Marine Park, they can go oh, movement of fish through the Marine Park, and then read that one page.

- Easy to read summaries would help.
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- The CSIRO communication group helps scientists present their results in a meaningful way and organise communications, e.g. they’ll put our one pages into A4 glossies. does it on the WAMSI side. They should be involved in helping us produce the one page research summaries.

- Make it part of the next milestone report that the researchers have to produce a one pagers on highlights from their research. Then give that to dedicated communications team to put into laymen’s terms, or to create a more integrated picture. They can create flyers that can go into the research stations and visitor centres.

- Land holders and managers are not as interested in the research methodologies - it’s assumed that this is done professionally and competently. Land holders and managers are interested in the results. Don’t even go as far as providing specific management implications based on the research findings.

- [So you’re thinking the 2 page pamphlet would be like a summary of the research results, like the highlights?] Yes, and of interesting stuff – not dry, you know, take the best of the best. [And then direct them to find more information on the website?] Yes. Because then they can’t complain. I would also provide such information to the Ningaloo pastoralists (comprising of only 5 stations) because they are the land managers on the coast. I would also suggest direct contact with the town planners at the Shire of Carnarvon, Shire of Exmouth as well as the GDC. If this isn’t done, all of this just becomes a doorstop document that is going to gather dust on university shelves in Perth. And land managers and tourism operators will just keep doing what they do every day now according to the priorities they believe there are, because they’ve not been informed otherwise.

- Today I had a phone call from a member of the public who was concerned about environmental issues and they asked me ‘Would it not be possible to get some of this information, even as a pamphlet, out onto the site so people can see where the money and the resources go?’ That is a great weakness because none of the landholders / managers have the resources, time or the skills to produce that quality of document. It really has to be a glossy pamphlet of say 2 pages stating here’s the relevant website, here’s what happened and here’s where you find the results of the research.

- Just simple, boom, boom, boom, easy. And then if people want more, oh, well, how did you come up with this conclusion, well then they can give them all that data. If we want to ask more, we then email them and go ok, well how did you come up with this conclusion?

- Then after they do the research, bring out like a fact sheet. Bring out a, not a scientific fact sheet, a commercial fact sheet, tourist fact sheet. Ok this is the research that was done, this is what we’ve come up with. Ok the turtles lay their eggs blah, blah, blah, just a nice simple form we can add it to all our info we give our clients, so more a tourist information fact sheet. We don't want to know what processes they went through to come up with this information.

- But would the marine science research- which is probably of greatest interest to locals and operators and who want to put it in their interpretation of the region – be better communicated by sending out a short fact list to operators and doing promotion in local newspapers?

- What we need to do next is complete the brief summaries of research and management impacts, and work out how to get them out (on the web, in a forum, etc.).

4.3.4 Research reports

- The focus for us right now is the initial products, the final reports, what is the most useful information and how to present it, and getting it out in the next year.

4.3.5 Government briefings

- Next, we need to prepare some brief communications clearly demonstrating the management issues and the need to invest. We need hard nosed briefings with key “what’s in it for you” comments, and what’s going to happen if government is found to be derelict in its duty, but said nicely. Could use this to create interest in setting up a local office to staff the models, a small initial ask.
4.3.6  Online

4.3.6.1  Set up a website

- A website’s good. I don’t know if you’ve seen the Jenners Centre for Whale Research? On their website, they’ve got all their published articles from their research there in a PDF form, so you can just click on that and you open it and you’ve got something there that tells you what they’ve found in a fairly easy to read format. I usually concentrate on the intro and the conclusion. I don’t read the methodology. But it’s something that you can actually reference but it’s useable for the public as well. That’s quite good, that set up.

- Personally I use the internet a lot for lots of stuff. I don’t find hard copies very useful, it’s a lot of paper and generally quite long. You end up with 150 pages of which you need 3.

- A website would be good that we can go to and refer to. A website to say ok this is what’s been going on, this is how long we’ve been doing it, this is what we’re looking for, and these are the conclusions that we’ve

- Maybe even a website that can be updated, where you could go and click and see, ok, at the moment these scientists are actually in town and this is what they’re doing. And this is what they’ve found so far or this is their report.

- Who’s got time to sit down and try and work out where they’ve put this information. If it is on a website that’s accessible, and even if that website is then ongoing one for any scientist who comes here, even if it’s a brief summary of what they’re doing. I don’t know how that could be coordinated but DEC obviously knows because people have to apply for research licences so I mean, they must know who’s coming and going.

- We don’t just want a book. A website, absolutely, a website. So I can just go on a website, pull out a dropdown menu, and go, yep, that’s what I want to find out about, and that might be linked to this. Give me a summary of the data, but if I really want to get down to the nitty gritty I want to be able to drill down to the details.

- I’m not really up there with online and computer stuff, but I guess they could have a library of Ningaloo research accessible on the web, so if you Google ‘Ningaloo research’ there’s a website with easily accessible papers. So you can just click on the paper and boom, there is it. Something like that would be fantastic, then anyone who’s looking for any research at Ningaloo could find it. There is some exciting potential there but I think the key is the useability of the stuff really – and being able to access the research. But that should be fairly easy with a website. I reckon just being able to Google it and get it online via a website would be fantastic. And that would be pretty easy to set up, you wouldn’t need big bucks for that.

- You can have the information sitting on a web for those who want to access it that way.

- I don’t know where the research should physically be. It may be that it doesn’t need to be physically anywhere, it could be online. I mean, I’m sure someone will suggest that the CSIRO should build a dedicated website to research here and stuff. But I don’t know, a lot of money can be p*ssed up with making websites like that.

- From DEC said there is a Ningaloo Research website. Even if this website is the main hub for all the research publications and results, also produce a 2 page pamphlet where you tell people ‘if you want the detail of the research, if you are interested, go to this website and look it up’. Because they all have their computers onsite and they’re sitting around bored when the waves or wind are down.

- So it’s difficult. I believe the key to it all coming together is getting the research which has been done, presenting and making it accessible in a way so Joe Bloggs, my rangers or whatever, can just go to a website and find it.
To get some sort of result from these research programs the information has to be put in a form that the general public can understand – whether that be a website or some pamphlets or something that has easy access for people to get a hold of.

4.3.6.2 Link to established websites

- They should link the research results to known websites, like the Shire website or the Ningaloo Research Centre, things that people are aware of. People are aware that the NRC is planned. If you could somehow link to the sites that are really accessible and that people are very aware of, that would be great. Or the Gascoyne Development Commission website...that’s another good site that people are definitely aware of.
- You could also link the research results through the Visitors Centre website.

4.3.7 Ningaloo Research Centre

- The research that’s been invested in Ningaloo is invisible to most people – they’re not aware of it. A research centre would be a way of communicating the research and making it visible.
- The research centre will capture research in the region for perpetuity, whereas planning bodies will come and go (e.g. NSDC). This way the research won’t get lost with the office.
- The locals know what’s on the ground and in the water, and they take pride in it. The research centre would be a way for the community to express that pride; it could serve as an icon for the community and the area, and be a source of local pride.
- A building speaks to people. They can look at and touch things. This will capture their imagination more than a flyer or fact sheet telling them where to look up information/research.
- We’ve been having talks about setting up a website before the centre is actually built, one that links to all the researchers’ work. We want to hook into all the work that’s been done before the researchers leave.
- To me, it’s having the Research Centre for interpreting research, not wads of scientific terminology and information.
- The Learmonth solar observatory as well needs to be included in the Research Centre up there. It’s a joint thing between Australia and the US. It monitors the sun and all the solar stuff 24/7. It’s one of the most important solar observatories in the world. Everyone drives past and goes, ‘what’s that?’ but you can’t get out there. To me the Research Centre should be the hub for information on Ningaloo, information from DEC, information from WAMSI, from the solar mob, and it’s all in one area where people can find it. If I’m an independent I’m not going to trawl through seven websites to try and find information on Ningaloo. And I think the Federal Government needs to subsidise that as an educational facility underneath the GDC. I reckon if someone had a business plan, it would.
- With the Research Centre you’ve got 110,000 people coming in – guaranteed. People that are here for a week don’t want to go out on a boat every day, they don’t want to go to the beach every day, and they want to have some land-based activity to do. So even if you got 50% of those people there, you’re educating 55,000 people a year. And that’s also how you get your community lie-in, because it’s all about local community knowledge. To have a facility that’s doing that, you’d have your locals interacting with it as well.
- You need something centralised. You don’t want to have seven websites to go to - DEC dot this, and WAMSI dot that. And once again a website needs maintenance and someone doing that sort of thing. Yeah, the more I think about Ningaloo the more important the Research Centre is, I think.
- The Research Centre would be like having a spokesman. Every time you hear on the radio they’re talking to some person, they’ll talk to a turtle person from DEC, they talk to another person there, you don’t have the same message coming out, it’s not consistent.
- And I still think you’ve got to have someone paid [to help the research centre]. Like any successful event, the first thing they do is put an event coordinator in a paid position, who gets the website going, who gets
the information out, who does all the stuff. So everything we’re saying that needs to happen isn’t getting done because no one’s got the time or resources to do it. And effectively they’re doing it for their own agencies, because DEC will say they’ve got it on their website and they can say we’re doing it, but no one’s pulling the whole thing together. And that’s that place where people who want to do a PhD, from Canada or Melbourne or New Zealand, go look and think, wow, yes; this is where I want to go.

- The macro stuff is sexy, and you can tell the stories and show the pictures of it, but it’s the micro stuff that is the base for the macro stuff to exist so you’ve got to protect them... That’s where the Ningaloo Research Centre would be ideal. Those research documents, whether they’re in electronic format or whatever, could be made available to the Research Centre once it’s constructed. We would try to spread that information to the public, and allow international researchers to have access to it as a one-stop, rather than having to search through the university databases. All of the information would be here for the public to read for the whole Cape region.

4.3.8 Ningaloo book(s)

- A coffee table book on the research done in Ningaloo is a good idea. This is something BHP Biliton has expressed an interest in funding. It’s been something that the CMC and Ningaloo Research Coordinating Committee have discussed and there is interest. Andrew Heyward (AIMS) has had a strong link with BHP and experience in gaining funding from BHP for science. In terms of the overall knowledge and technology transfer this is an element. It’s not just the product, however, it’s the process of developing it, who is involved.

- It would be good to write two kinds of books about Ningaloo: one coffee table type of book with some basic science on ecological processes and how humans impact the reef and many big high-quality photographs about marine wildlife, and the second a proper scientific text book. There’s money to be made – there are no high-market Ningaloo coffee table books that I’m aware of.

- Could have profiles on the researchers doing the science – putting a human face to science.

- I’ve talked to CSIRO people about the book idea – they might have someone in CSIRO who could do it. Maybe I’ll push it a bit. You’d need the photos.

4.3.9 Hard copies/mail/flyers

- [So are you interested in the research? what’s the best way to get it to you guys...?] Absolutely. By mail would be the best way because what we’ve got is printers that you’ve always got to have toner for, if you get it emailed, you’ve got to print it out, you run out of toner. I think hard copies could be mailed and then we could file them and they’re easy reference to just...you can just pull them down and have a system. That’s how I’d like them. I don’t know about other people but that’s how I’d like to have them.

- [In a hard copy, digital copy, website?] A hard copy is probably best. If you’re seriously going to sit down and read through it, flicking through it on a computer screen drives me insane. And then you can highlight stuff on it and it’s easy to refer back to.

- [In terms of getting research results to people in the community], I think different things work for different people. In a community like Exmouth you won’t necessarily have people up-to-date with technology as far
as accessing the web all the time. Nobody reads e-newsletters, you get inundated with e-newsletters. I'm actually more inclined now to open up something hard copy and have a look at it than I am to open up something in email. You've got a million emails that you've received, you might think, 'well, that's not an important thing' so you don't open that e-newsletter. Whereas if you're opening mail something might catch your eye. With e-newsletters it could be 6 weeks before I look at them. I have a friend who's a consultant and he's a business consultant, and he sends out e-newsletters. He's actually got a system where he gets a report about when you opened his e-newsletter, if you opened it and how long you spent looking at it. He'll be thinking 'she didn't even bloody open mine.' Terrible! And he said, he will get a whole heap of people that will look at it that day and then most of them about four weeks later.

- But you could do it in terms of a flyer in their letterbox or something. In the stuff that we've done, we've found letterbox drops really effective, and there was one we did about Straits and we basically just kind of had a Mythbusters sort of thing, and on the bottom of it was a submission that people could post in. We had a really good response to that. So I think flyer drop would be good to supplement perhaps with the presentation, but you'd have to market that pretty strongly to really get people in.

4.3.10 Newsletters

- I mean, the other thing could be an email newsletter, if it doesn’t exist already. I think their quite effective. I think that would be really good and that could go to all the locals and they can’t complain – ‘oh, I don’t know what’s going on in the…’. And that’s what we do, we do two full pages in the paper every two months and we actually make that into an email newsletter and that goes more widely to people in Perth who might be in similar regions. [You’ve got an email database already? Is that something we could tap into?] Yeah, we could probably…I don’t think we could give you the database but we could do sections…yeah, we could do that.

- Get information to non-scientists via newsletters etc., for example what they’ve done with the Great Barrier Reef. Could have newsletters with news about the park and a science section, education in schools, public talks, radio interviews, media involvement, pamphlets in visitor centres, especially on less conspicuous ecologically relevant processes like herbivory (there’s already lots of information on whale sharks for example).

- Or if people don’t want to do talks, maybe a monthly, quarterly or six-monthly research newsletter that comes out that summarises what people have been doing, what they’re going to be doing, any results, and maybe even if there’s an opportunity for people to get involved.

- But you still need to target people, although it’s not very many these days, who don’t have access to the internet. That’s where the newsletter comes in.

- Website, talks, forums, a newsletter, because if you have got people who don’t have access to the internet or older folks. I mean, obviously there is a cost involved but it doesn’t have to go to everybody in the community. It can just be to people who want it. So you can easily set up a database for sending it out, and also have the newsletter visible, right near noticeboards that people read. Like for instance, there’s the Cape Conservation Group noticeboard, I know that we would be happy to have it there. There’s also the big noticeboard near the Post Office which was a DEC one but is used for all sorts of things, DEC put a lot of stuff there.

4.3.11 Contact database/email

- Researchers should get everyone’s contacts and send their results out. How many times do you not hear about a research project that you contributed to. Like almost all the research is doing up and down the coast, if he had contact details for all those people, he could put together a contact email list for distributing information, then you’re touching another 40 to 50,000 people down the Ningaloo Coast… I just wonder if he does that sort of stuff. If you interview someone, get their email, then you’ve got an email list, a database of people. Send them an email saying this is the research that came out - they might delete it, they might read it.
You get the research out by having a person who works at the Research Centre who is maintaining the contact database. You know, really, that’s how it all happens. But everyone says ‘we should’ but when it boils down to it, it takes work to manage a 10,000 people database. So no one’s going to do it. But if you’ve got someone sitting in the Research Centre getting paid to administrate it...

Another way of getting the research out into the community and to other researchers would be to use a manager who could maintain an email list of stakeholders and send them information. But I think that would probably be difficult to maintain with such a broad range of stakeholders.

4.3.12 GIS/maps/Google Earth

It’s a two stage thing: we have to get the scientists to come up with a product, then we need to think about what form it will take. Maybe some GIS maps, etc., simple things that people can relate to and that don’t require the MSE model. These products can help build people’s understanding of the system so they’ll be more confident to ask questions of Beth’s model. This needs to be taken up by the management committee as an urgent task.

With regard to the spatial visualization of data, my questions are: visualization for whom? For what ends? What groups are you trying to reach? Visualization on Google Earth would be a good way to give people from Perth an opportunity to understand where people go and what’s going on in Ningaloo.

4.3.13 Schools

You’ve got a high school here in Exmouth, perhaps working through the high school and presentations to the children, I reckon that’s good. Maybe do the same in Carnarvon. It’s got to be pitched in the right way and the right level but yeah.

I don’t know enough about the educational system but I think you’ve got to get kids into a bit of an ownership thing with information. It’s a generation thing and the new generation is much more computer literate and culturally and environmentally aware than the previous one. But if you don’t see them educating themselves about it…I don’t know how that can be done. But you’ve got to have some form of schooling system involved.

There’s local Exmouth kids, but you’ve also got to get the schools up from Perth, like the guy who does school camps in Coral Bay, [name]. I think he gets about a thousand kids up every year. He runs a business but it’s focused on school groups and camps. So he gets, let’s just say it’s 50 kids a week, from Mercedes Ladies College, and he’ll take them out and show them the reef and he’ll get them on a glass-bottomed tour or he’ll do the snorkelling, but he’s not giving them all the research information that’s out there. He’s educating them on Ningaloo Reef definitely but it’s with [name]’s school of information and we want to get him as a kind of conduit of information. Then you’ve got that continuity into the Education Department so effectively you don’t even have to bring a school group up but you know the information’s there. But if you want to do something on Ningaloo’ like if we get a teacher up here and they go, ‘shit, Ningaloo is great, I really want to promote it, where do I get the information from?’ …there’s seven different websites for Ningaloo, or different individuals …

For example, there are school groups going up to Shark Bay and they’re staying at Hamelin Pool Station, but they’re not getting consistent information about the place. There needs to be centralised source of information. And content-wise it needs to be for everyday Joe. With a link to view more if they’re interested.

Say we’ve got a thousand kids going to Shark Bay and we’ve got a thousand kids coming into Coral Bay. They touch 4,000 people back in Perth because they’ve all got parents and families, ‘what did you do’ and all that, so all of a sudden you’ve got 4,000 people educated. You do that every year...

If you’re going to present the research results to the community, I would suggest that be done through the schools, that you actually try and host maybe a couple of nights involving the schools – because that’s going to get parent involvement. The one thing that this community is not good at is participation.
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- It is complicated to actually get groups of people to an event. The Gascoyne Games was not much of a goer, because of low numbers. The after-events received the numbers, and that's disappointing. I think that we all have a soft spot for kids and if the kids were the ones that were driving the night rather than the researchers or government departments, then you might actually get a far bigger participation.

- The schools actually have a great participation rate. The high school biology teacher has been a great driving force for the schools' environmental participation. They do the echidna counts teachers go out on whale shark experiences and all that sort of stuff. Just a few years ago we were trying to get up a local citizenship award and we wanted a new logo for it, so we asked the schools to run an art competition to show what kids thought would represent a good citizen. We probably had maybe 60 or 70 entries – and of that, I would say 90% showed some environmental – whether it was protecting a turtle or picking up litter. So you’ve got a basis for a great deal of environmental understanding through the school, and that’s why I think driving it through the school would be a good idea.

- That’s why I thought that the school would be a good basis because if you get the participation of the high school students, then you’re going to get the participation of the parents and it should then go out to the wider community.

4.3.14 Library/community centre

- There’s also the town library too. When oil and gas or others put in proposals or referrals to government, environmental assessments etc., a public copy goes to the library so there’s actually hard copies. I’m sure most of the hard copies have electronic copies in them. They’re within the library so anyone in town can then go and view them. I don't think the average person knows they’re there. I don’t think the average person is really aware that they can have an impact on decisions that are made. [Do you think it would be different if they were aware?] They’d have to have the motivation.

- The town library would be good. And the new community centre they’re throwing ideas around about, I don’t know if you’ve heard about that – they’ve had a community meeting and they’re talking about whether we need a community centre, mainly for sport, but cultural and all that stuff too. The consultant is coming back to deliver a few ideas on what he thinks are the best for Exmouth, and he was talking along the lines of having it as a big community centre, moving the library and incorporating a toy library and story-time and play, and a skate park and near the oval. So the library might be getting a big reinvention in the future.

- This information will be of benefit to the community but if it got buried in the public library, well that is exactly what would happen, it would be buried.

4.3.15 Displays/showcases

- The research results need to be advertised as available and it need to be at different locations. Certainly the Research Centre once built will be an ideal site, but in the meantime perhaps the Game Fishing Club, the Visitors Centre,

- Fisheries research is of interest, because such a large part of the local population, as well as tourists, fish here. This information would be of interest to groups like Gamex, and the Exmouth Game Fishing Club. EGFC are close to starting the construction of their own clubhouse, so perhaps some of that information could actually go into an area like that, to be shared for all those that have an interest in that area.

4.3.16 Media

- This region has got one paper., the Northern Guardian, but it’s one paper covering the whole region from Shark Bay up to Exmouth. You’ll notice a lot of organisations have, ‘advertorials’: we take two pages in the middle every 2 months. The Shire of Carnarvon they take half a page every month or so. If you just had, in the course of your communications plan, something regularly in the local paper, you could do a lot worse. Even if you went out and bought some space, just once a month/every other month, and talk about how the work is carrying on. We’d be happy to provide local input for to communications strategy, so it’s effective for this area.
Some of the research results could also be published through DEC’s Landscape magazine.
Designing research for better uptake

1 Planning research

1.1 Make communication a requirement in grant proposals

- In the UK there’s a requirement to present a communication proposal along with the research grant application. There has to be budget associated with it (very important to ensuring it gets done). The communication proposals are assessed with the grant applications, which are sent back if they don’t have an adequate communication plan. Every proposal which is funded needs to have a suitable communication strategy. Pippa Moore might know more about this – she’s from the UK.

1.2 Spend more time scoping

- We don’t invest enough time thinking about how we’re going to do things, and we rely greatly on structure rather than process. In the early phases of research projects we need the space to think and explore things, without predefining everything we’re going to do. We need to be comfortable with uncertainty in those early days, but that’s not how science works – it’s a paradigm issue.

- The truth-seeking, hypothesis-testing orientation gets taken a little too literally in the project proposal stage. Scientists don’t scope – they see gaps in literature that they find fascinating, but they don’t necessarily talk to the people in a study area to see how it fits in the big picture. Fear of uncertainty means scientists feel the need to predefine everything in their project plans, rather than starting with a scoping exercise.

1.3 Use interdisciplinary approach to project design

- When developing a research project it would be useful to bring other experts, like social scientists and communications people, onto your science team to help design community engagement processes and processes for communicating science. But even when social scientists are involved in the project design phase they’re not always appreciated for what they can offer; often they’re just told what they’ll be doing. I’ve never known a communications officer to be involved in the project design phase.

1.4 Relate research to management

- Through DEC, and people like [redacted] etc. are constantly asking what the management implications of our research are, what does this mean? As scientists we don’t often think in those terms – it’s good that we’re being asked to think about applications – I haven’t been asked these things before. We’re being challenged and it’s good.

- We need to really encourage people to think about where their research is going and how it interacts and coordinates with other people’s work.
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- It's the management committee’s role to interpret the research from a management perspective. We need to go to the scientists and say: this is how we see your research fits in from a management perspective, what do you reckon?

- Someone needs to sit down in conversations with the researchers and ask them: what are the key things you want people to know about your research? How is your research useful and who needs to know about it?

- How do these researchers see this information being used? How is this going to be applied into the management systems we've got? E.g. to make track rationalization research work, there needs to be an open forum with managers, rangers, etc., not just the district manager - he can't make sure everyone knows what's in his head.

- Researchers should also talk about issues around research from the manager’s perspective – you need to get people/planners to own the requests for research, and you need research that meets the needs of managers.

- The management plan (Ningaloo marine park Mgt. Plan) came out with requests for research, and a lot of the research projects are focused on meeting these requests for research. But it’s important to get as much management information out of that research as possible.

- Ideally our planning should be addressing issues that need to be investigated, and the research should be focused on those issues. And that happens with the marine research in Ningaloo, but how that links back into the DEC systems is a question - the development of an associated DEC system for dealing with the research might need to be looked at

- Researchers should come up with total outcomes and directions for management (rather than presenting their results separately), and for the whole of the park, because often researchers focus on a small area. For managers it’s the outcomes and management directions they’re interested in, not all the data and the theory.

- There’s no point doing research if it’s not going to be implemented by management, it has to be connected. They might say there needs to be more research before management directions can be ascertained - then we don’t necessarily need to know about that project. In setting up a project, surely there is a reason for them doing research that is relevant to management. If it’s not relevant to management we don’t need to interact with them.

- [Do you think it might difficult for researchers – who have never done management – to think about management implications of their work? What if researchers don’t see their job as implementing? What if they just see there job as producing data then letting someone else take it from there?]. Well that is living in fairy land. In fact that is the issue, because the managers aren’t researchers. That interface between researchers and managers needs developing. Our planning should foster more interaction between the two. The communication between relevant parties is so critical and it links back into our planning and consultation processes.

- The key thing is for appropriate people in DEC to interface with the coordinators and heads of research institutions. Researchers should not just meet with [redacted] who is focused on research, but also the managers at the planning and implementing end. Ideally all the information should be funneling into [redacted]’s unit, so you could just talk to [redacted], but I don’t think we’ve got to that stage yet – management procedures etc. are still evolving.

- I reckon it’d be great for the modellers to come out for 2 or 3 days, come out with us in the park to see our issues and what we deal with on-ground as a Department. This is reality. Bins get emptied every day. People whinge every day. People drive across every day. We have a sign there, yes, we’ve blocked that access. Do they care? No. It’ll be good for them to actually come on the ground as well. 2/3 days you get a very big insight into what happens in this park. Stand at the gate at 8 o’clock in the morning and listen to the abuse. They’re the things I think would benefit both. I think that the research is a huge benefit if we know how to get the parts that we need. But vice versa, come out, have a look and go, geez, this is reality on the ground. Until you’ve stood there with 15 campervans and people getting angry, it’s like shit, ok, this is a real issue for these guys. How does it all link, that’s what I want to know.

- The ground staff, we try to provide input into the planning, but often it’s not taken on board because they’ve got their models. So that’s where I’m such a strong advocate for getting people who are planning and a few of our recreational guys out here for at least a week or two before they make a decision on ‘we’re going to build a shelter there’, etc. Because sometimes all the models and the planning, it doesn’t happen.
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- I worked 12 years for a state agency delivering research to managers. We had a very tight relationship between researchers and managers, with managers often being involved in directing the research, but some managers were too harried to get involved and so did not always effectively use the research. [How could you help those managers who are too harried to take up research?]. What really worked was when we had close relationships with the managers and we answered question they cared about. It’s really simple, isn’t it? It’s not hard to do – just have to have researchers working alongside of the managers. Not sure if this was always the case with Ningaloo, as there are multiple research and management organizations involved, so the institutional distance must first be closed. Research uptake is a harder sell if the research questions aren’t developed with the managers, even if the questions answered are potentially useful to managers.

- The quality of the field work and methods of research made a difference in the uptake by managers. They defined research quality by the statistical design, structure of the survey, answered the problem at the correct scale for their use. For example, an endangered species petition brought forward by an NGO was dropped based on research – our research project had a good reputation, and my agency had a good reputation with the decision-makers, and our survey design was nationally respected. In the end we produced a one page table with our survey results, and they based their decision on that. I met with local groups and industry representative during the height of an anti-environmentalist backlash. I met with them often, talking about the research objective, talking science to the public. Many were convinced, but then again, many were not.

- [Did any of these researchers come to you guys before they started doing their research to talk about methodology etc.?] Yes, I’ve talked to Anna quite early on when she was just taking up, about what I see as issues along the coastal strip. But how that translates into the method of what she does and how she evaluates it, I don’t know, I haven’t seen that next step. In some ways it would be good to have managers as co-supervisors for students. I think that sort of level of co-supervising would be good. In the early days some of that was happening, but what I found was that in academia lecturers get funded by the number of students they take on. So they take on too many students, and they don’t have time to give them direction.

- The stuff they’re doing out there is fantastic but it can’t be pure research anymore. There has to be applicability too. It’s really nice that we know that this is happening but if we can then take the next step and say, OK, from that we can now work out that we really need to organise how we are managing this area so that this, this and this happens. The way I see it, it’s the next logical step in progression to take what research is being done and put it into the management programs. Potentially that’s something that has always happened but it’s been driven by the people who are in the management positions. OK, you do a literature search and find out what’s been happening and who’s been doing what and think, OK, well I’ve got this paper and this paper and this paper that I can cite to say ‘this is happening therefore I’m going to make this management decision.’ It would just be really good if there was some way of refining that process so that it was more of a…more of a normal procedure. OK, the research happens and the people who need to know are then in the loop as to what needs to be included when you’re looking at management stuff.

- Everyone [managers and scientists] has been doing their own little bit in isolation and we really now need to be far more integrative, because it’s a much bigger picture thing now.

- Then there would have to be a backwards and forwards as to, OK, you’ve found this result, your next line of questioning goes off in this direction, but from a management perspective it would be really good for us to know this and this and this. Is there some way you can incorporate that into what you’re doing so that it’s more of a win-win situation in that yes, you’re getting the data and the questions that you’re interested in, but it’s also providing us with a venue for providing the things we need to know to manage.

- My understanding is the way research dollars are going at the moment, there’s more emphasis on justification, as to…OK, why do you need to do it and why are you doing that kind of thing, and obviously if there’s a practical applicability component in there, it’s going to be a better justification for them as well. That potentially even needs to come in at the planning process. So rather than saying yes, we’ll be there in two weeks and this is what we’re doing and we say, well actually, while you’re there could you do this, this and this as well.

- [To better integrate research and management] probably the easiest way to go would maybe a quarterly meeting, like a teleconference or something like that, because I think it’s something, it could end up being bigger than Ben Hur, depending on how many researchers you’re involved with, how many institutions, and the timing that they
want to do things. It’s also going to depend upon the number of areas that they want to look in. If they’re doing marine parks up and down the coast, and they need to have a meeting with us and a meeting with Jurien and a meeting with Shark Bay and wherever… there needs to be flexibility to start with because there’s not going to be one thing that’s going to work for everything.

• People need to get together on an agency basis, with representation from both sides [research and management]. Then we can say OK, this is what we need to happen from a management perspective, and then the researchers can say well this is what we need to happen. It would be better to deal with one person responsible for program management from CSIRO, rather than having ten different researchers ringing us up and saying how about this or how about that.

1.5 Have a post research presence/plan

• We need to help the researchers create the networks, relationships and collaborations with other people who will help the research continue its journey, so the research isn’t a dead end.

• What’s needed is a corporate research governance responsibility that from project conception there is a plan for post-research presence to help translate what we’ve learned into practice. It should be a standard output in everyone’s proposal.

2 Promoting collaboration and engagement

2.1 Promote interdisciplinary & community collaboration

• When developing a research project it would be useful to bring other experts, like social scientists and communications people, onto your science team to help design community engagement processes and processes for communicating science. But even when social scientists are involved in the project design phase they’re not always appreciated for what they can offer; often they’re just told what they’ll be doing. I’ve never known a communications officer to be involved in the project design phase.

• With the Ningaloo project is there is a different vibe in how the scientists operate. There was a lot of trust before people started working together, a luxury you don’t often have in the real world. Some people in the projects have known each other for decades, which has allowed them to resolve conflict and take risks. There’s a lot more communication between silos and disciplines in this project. I haven’t seen this type of interaction before. This is why Ningaloo is exciting – there’s trust and transparency.

• Social scientists have had a surprising amount of acceptance in the project. The [redacted] project was the first one where social scientists have been brought in because they’re worried about what’s going to happen with the research. It’s been left to the end a bit, but I think there’s still time for community engagement.

• My role has been to help the researchers from disciplines to communicate to each other and make sure they can understand each other’s, and extension to DEC. In this regard I have functioned as a facilitator.

• This is the perfect opportunity for cross disciplinary collaboration, which we don’t often see. Scientists miss opportunities to collaborate with managers, political scientists or communications experts, etc. and therefore integrate science into the real world. I don’t think it even enters people’s minds that they should communicate what they’re learning.

2.2 Employ coordinator for research-management interface

• Ideally I think there has to be someone as a middle man [between research and management]. That would be really helpful, if you can get that integrative process [between science and management] because it may be that a lot of the researchers would turn around and say, ‘yeah, it’s not a big deal.’ It’ll just involve doing this, this and this, or reorganising this in some way’ or it may also be it’s something that they just wouldn’t have thought of, which
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would turn out again to be a really valuable contribution because it will have that practical application for what they're doing.

- It would be good if there were some sort of coordinator, a middle man sort of thing, to go to within each agency or institution that just sort of oversees that sort of thing [research/management interface]. So if a researcher comes along and says, OK, I want to do work on turtles and I want to satellite tag them and see where they're going and where their feeding areas are, there is someone they can go to who can say, ‘Alright, well your options are you could work in Ningaloo, you could work here, you could do that, and these are the types of questions that they're interested in looking at.’ And just sort of get some sort of loose framework organised so that then when it comes to the actual project specifics, they at least know well these are the parameters that management are looking at… and then potentially it could look at, OK, let’s get into a bit more individual dialogue and try and get it happening that way.

2.3 Engage communities/stakeholders in research process

- A bottom up approach would involve defining research questions with the community from project conception. And having them on the journey via a co-research processes incorporating social learning, so people could learn how to interview, how to tag fish, etc. But these things take time and money and often the researchers don’t have the skills to set up social learning strategies.

- I think the power hierarchy also dissolves, because it’s not just information being provided by scientists, it’s also the scientists recognizing the power and knowledge of the community. The community have really complex questions that need to be asked, to test the model.

- There are also opportunities for communities to contribute to the transformation of science into the real, practical world. Rural communities tend to get cast in a negative light, and that’s a problem.

- The scientists going to the communities and spending time is really important – to themselves communicate what’s been going on and what they’ve been learning. It’s also important for the researcher to get an understanding of the world view of the community members. I think those silos are beginning to dissolve with more interaction between people.

- Even though there are tried and tested recipes developed over the past hundred years for how to do things, maybe some of those recipes aren’t working anymore. Maybe we have to look at some overseas models [that focus on community participation] that yield better results. Confronting as it is, maybe we need to adapt the recipe we have and tweak it. Don’t throw the recipe away, tinker with it, make it work better.

2.4 Engage stakeholders in model development

- Our milestones focus more on development of the model itself, but what you realize through modeling processes is that important aspects are more about engagement and relationships.

- Flexibility is part of [management style]. From the beginning we’ve adjusted the model to the needs of the people we’re speaking to via a series of forums and stakeholder engagement. This is because key people involved in the project had a background in adaptive management and organizational learning.

- We engaged a large group of people in the public forums but the input into the actual model was done in smaller groups who worked on different sub models. This approach was used by [past] in the past. In retrospect I would have liked to use a smaller group of stakeholders meeting regularly to design the model together. I think that’s the way that these processes have been done in other parts of the world. The strengths are that you get a smaller group of people, hopefully prominent in their particular networks, who begin to reform their understanding of the systems in which they live and operate work (by testing their own conceptual models), and then they can act as advocates for the community. Whereas trying to do it in half hour periods in public forums is a big ask.

- It’s amazing to be asked, ‘What do you think the model could be used for? How could we use the model or make it more effective?’
2.5 Prepare for conflict

- We deal with conflict in public forums by acknowledging the contentious view (rather than contest it) before moving the workshop on to the next point. Then afterwards we go back and talk to the person.
- One of the pros of our approach we’ve largely sat outside local politics so we can be seen as not being subject to particular regional interests. That’s probably why the Shires are so interested.

3 Managing innovatively & effectively

- So far the cluster management committee have been really good at getting science on the road and identifying the key problems and vulnerabilities of the research program as a whole. Internecine interactions have been concentrated on, and they’ve gently pushed different people in different directions, and responded well to new projects.
- The management committee have produced an atmosphere I’ve never seen, with one other exception, in 30 years working for CSIRO. The three of them have been great, making sure the knitting is getting done while allowing new ideas and innovation, which is a nice balance. I’ve stayed involved with CSIRO because of the management committee, and I wouldn’t swap it for anything – it’s been one of two really good projects I’ve been involved with. None of them fight, they support each other, and people have a sense of security in what they’re doing. They’re not passive, they deal with problems, and no one has been hurt. People have changed because of the atmosphere – people are happy about changing. But the next part has to be done well as well.
- All three have been highly successful men in the past, and don’t have anything to prove anything to anyone or compete – they’re all secure individuals who like people.
- One member is a pragmatic operator in terms of getting good will with people; the other worries about interlinkages between things so can we get a coherent package, and gently deals with issues internally that have threatened the cohesiveness of the project. The third is an ideas person, a natural integrator and encourager. What a great combination.

4 Changing research culture

4.1 Change research culture

- We need to create a research culture that’s collaborative from beginning to end, and more focused on impact in terms of getting research used in the real world.
- There’s some pressure on this project because the question of why so much money is being spent on research was brought up in senate. The climate is such that we have to prove ourselves or find a different job. I think we will prove ourselves, that our work has a continuing management role, that it won’t just be a big one-off study that then sits on a shelf.
- Researchers giving a damn about what happens after the life of a research project would require cultural change within organisations – at the moment this [Ningaloo] is exceptional practice. It needs to be standard practice when we exit a region. Caring about what happens to our science doesn’t happen automatically. That might help facilitate people’s cultural change. Maybe if it was a requirement on paper they would ask for help from communications officers, social scientists, etc.
- Critically, I think there needs to be cultural change in how research is conducted. The norms on how you do things need to be shaken a little – change freaks people out, alienates them and makes them defensive so they shut down. I don’t know how you do it – you could host workshops explaining what social scientists and
communication specialists do and the value of collaborating, but people don’t give a damn and they wouldn’t attend, because they don’t have enough time.

- If we change how science is conducted in a structural way (in the planning process) that people are more comfortable with, maybe it will gradually influence people’s mindsets and value systems till it becomes normal. It may be less confronting.

4.2 Be willing to take risks

- The Ningaloo Cluster is an example of gradual cultural change. Why? I think it comes down to personalities of some people and their willingness to take risks. This willingness to take risk and experiment comes down to Bill. He’s provided the forum for people to do that. The beauty of the NCC is that there have been avenues for taking risks, and I see it in some of the key researchers and managers.

5 Evaluating research

5.1 Change performance standards

- The science policy that I’m writing for the Science Division has got a productivity framework in it to assess productivity of scientists. It has the traditional science outputs that you would expect, publications, etc., but it also has communication (popular articles, interviews, etc.) and knowledge transfer. We still need to work on what these knowledge transfer outputs will be, but departmentally there is now a requirement for scientist’s productivity to be measured by these things. This is part of the legislated attempt to change the culture so that knowledge transfer is recognised as a role for the scientists too.

5.2 Document lessons learned

- Stories get lost, and I think the lessons learned and journey of this research project do need to be captured. A lot has been learnt, and I think there has been gradual cultural change within the cluster. But when you’re part of it you don’t recognize it, so it would require someone external to do that. And that would gradually introduce the process of scientists being more reflective of themselves, not just the science.

6 Licensing research

6.1 Consult local agencies when writing research license applications

- When the research applications come in and they say OK, we’re doing this, this and this and this is where we want to do it. And we then turn around and say, ‘I’m very sorry but it’s not applicable to do that in a sanctuary zone’ or whatever. And then they have to turn around and think, ‘Oh, well, shit, I’ll have to do something else.’ This discussion really is the last step in the process and potentially it should be a bit further up. If there had been some dialogue prior to that, the process would be easier. If the district had input beforehand, then licensing is just going to be able to go tick, tick, tick, here’s your permit. Whereas at the moment, the permits going into them, they send them out to the districts that are involved, we review them, put our comments in, they go back, get signed off and off they go. Whereas if we could sort of have a bit of dialogue beforehand and take that step out of it, it’s going to make it better for everyone really.
6.2 Share information on research licences

- Obviously, there is a division at DEC, because I had to apply for a research licence with my echidnas. But how that information is given to the people up here, I don’t know. I mean, it should be easy enough to do, once you’ve set some protocols in place, well ok, this one relates to Exmouth and Ningaloo so you need to just let them know.

6.3 Make reporting a condition for research licenses

- All the researchers that come here and do things, I think it does actually say as part of their licence conditions they’re supposed to provide a report. It would be really good if a copy of that could come to the areas that they’ve been working in. That would be a really good first step.
Regional Context

1 Ningaloo Research Centre (background)

- With research in the region, one of the projects that has certainly been keenly sought by the locals is a research centre at Exmouth, the Ningaloo Research Centre Project. It’s really a project that’s been around for quite some time now, I’d say probably since the early ‘90s and then there was some activity around that period and then it went dormant as I understand it. And it was revised in quite a substantial way in 2002/03 (that period). I came in 2005 as CEO of the Gascoyne Development Commission (GDC).

- The Ningaloo Research project is one that the GDC was very much involved in. We are a one person office in Exmouth; the Exmouth GDC officer has traditionally provided the Executive Officer for the Ningaloo Research Centre Project and its incorporated committee. Their work covers a whole range of things but perhaps the one single biggest project they do has been to support the Ningaloo Research Centre.

- We’ve made quite a substantial commitment to that project in terms of research in the region. The Shire of Exmouth has been our main partner on this but there are lots of other people involved. Our thrust has been that there should be a physical presence in terms of a research centre that can be used by researchers coming up to the Ningaloo area; not just marine but any researcher, any thrust of research if you like – there’s a base for them. There’s a wet and dry lab, there’s a facility to tie up a boat, and we have a site in the Exmouth Marina which has been earmarked for this project for some years by the government.

- It’s gone through various iterations. We did a feasibility study 3 or 4 years ago. Currently we have some money to upgrade that feasibility study into a business plan. We had a workshop a couple of weeks ago in town, where the committee had a facilitated session. We were trying to slightly reshape the project, particularly with the research that has been undertaken over recent years in this area. I guess we’re talking about $30 million worth. There is an opportunity for this Research Centre to be a facility where the public can come in and have the research, by Murdoch Uni and all the other unis, explained in a whole variety of ways. We would like to be able to demonstrate to the general public the research being undertaken and what the findings are.

- This State Government, the Liberal/National State Government, have got Royalties for Regions funding. That probably gives us our best opportunity to propose capital works. We’re in the process of re-looking at it, preparing some detailed plans for it and having a new business plan. It needs to be fine-tuned, it needs to demonstrate the differences between operation costs and revenue. It’s not so much a capital works problem, it’s probably more the operation costs.

- Some people’s reaction to the idea of a research centre is that it seems like a total waste of money. Certainly you wouldn’t want a research centre modelled on some of the eastern states ones. So you’ve got to be quite inventive about it. That’s why we want to really work harder on remodelling it into something that does provide a focal point/a place for looking at and understanding all the research that’s going on in the region.

- Look, we’ve talked to lots of uni people over the last few years and then we had a big mail-out to bring people up to date, about October last year to about 300 or 400 people, all sort of uni people – from the high to the low, from the vice chancellor down to the researcher. And I suppose when you get to a certain level people were protecting their money and they thought it was just something that might take their grant money and research money. The people who were more enthusiastic or quite enthusiastic about it were the real researchers, the guys who were coming up and actually going out on the boat and the guy who was staying in the caravan parks, a lot like you, and said, ‘well, that would be fantastic’. ‘Sure I could do all that but it would be made a lot easier if you gave me a real base.’ So at the basic researcher level the support was quite strong. When you moved up to the organisations, they were just protecting their patches I think.
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- I suppose the issue is they’re interested in research, not in regional development. They’re just not that interested and they don’t understand it properly and they don’t understand that it is a special part of the world that needs research and it needs to be valued and that having something locally is important. But I don’t think that’s at all on their radar. It’s very much about Perth.

- Ningaloo Ocean and Earth Research Centre will be a focal point for research in the region. It will include a research facility, accommodation for researchers (so they’re not competing for space with tourists) and an education/interpretation component. It would be a central point for housing research, and a place to interpret the land and the reef for visitors and locals. It would be a way to get research to the people

- The research centre was going to house government offices, including DEC, but they don’t want to go there.

- The proposal was initially driven mainly by the Shire of Exmouth and the GDC. Government will pay for the infrastructure, likely through Royalties for Regions, but we need to find the funding to operate it for its first five years.

- The universities are very interested; strong support for using the research centre was shown by people at the Ningaloo Symposium.

- There’s been some interest from industry as well. Funding it would give them the opportunity to show that they’re good corporate citizens, that they value the region and are doing the right things.

- We took a map to various ministers at the state and federal level, showing the eight research centres on the Great Barrier Reef. We have no research centres here, despite all the oil and gas in the area.

- The government should take on their loss-making facilities that are educational...like the Research Centre. The GDC should run it and it should be focusing on interpreting information from the research. And you do that by making it display or entertainment, and you educate people. Then you say ‘if you’re interested in more, here are all the places you can get the information.’

- I was talking to the GDC about it and I said you cannot put a business in there that will turn a profit. All you have to do is mitigate your losses as much as possible. The Discovery Centre in Shark Bay, the Aboriginal Centre in Carnarvon, together cost a million dollars a year in losses but it’s a free educational base. You start getting the educational... And the only ones that can do it is the GDC. I think they’re entitled to.

- The Research Centre, it’s a bit like the museums – it’s not a profit making business. I’d like to know exactly how much government subsidises the couple of regional museums. You’ve got to subsidise it, don’t you? You’ve got to have museums. The three centres are exactly the same to me. They’re educational, and I’m not saying they are, but they do the same thing. The Miner’s Hall of Fame up in Kalgoorlie. Exactly the same. And it gets funded by the government because they’re never going to make money.

- I’m actually on the Ningaloo Research Centre committee and, yeah, that’s an interesting one because my thinking is quite different from the thinking of a lot of the other committee members. Having been a research scientist and having been to research stations in Queensland, I’m just a bit concerned about their whole concept, because they were having trouble raising money and that still is a big issue, and WAMSI have said they’re not interested. A lot of the universities have said they’re not interested. AIMS is not interested because they’ve got their own floating laboratories, why transfer their scientists to a research facility on land when they’ve got everything on board?

- A few years ago, I said to them, ‘Look, it wasn’t supposed to be purely a marine facility, it’s supposed to be in multi-fields, not just marine.’ And the fact that they were having so much difficulty getting the funding for what seemed to be predominantly a marine, I mean, their logo is a whale shark, and I still think they’re pushing the marine side of it. And I said to them, ‘Why don’t you try promote the terrestrial, and in this day and age why aren’t you pushing for renewable – we’ve got so much wind here, we’ve got so much sun, wouldn’t it be good to have a research facility here for solar?’ And that’s where the money is at the moment. But they go, ‘Yeah, that’s a good idea’ but they don’t seem to be pursuing it. I just look at Coral Bay where Murdoch University just said, ‘We’re just going to have a little research station.’ donated the land and built a little facility, so why would Murdoch want to come up here when they can go there, that’s all most scientists need in the field. They don’t need a huge facility. I don’t think they realise about the ongoing maintenance costs let alone getting the funding to get it started in the first place. What
are they going to have there? They’re talking about a visitor’s centre but, you know, you need some pretty specky stuff to make it look worth people’s while going in there. Research scientists generally don’t like to have to stop what they’re doing and show people around.

- And they want to spend $1.9 million, that’s probably even more now because that was a few years ago, having this iconic manta-ray roof. And I said, ‘You’re having trouble getting money for this anyway and you want to spend $1.9 million?’ ‘Oh, but it would be iconic, you could see it from the road.’ Because they want to have accommodation there and seminar facilities and all of that sort of stuff. It hasn’t progressed in years and it’s not getting anywhere because I still think they’re pushing the marine and I just don’t think that’s the right way to go...I don’t think that’s where you’re going to get the funding. If Newcastle, which doesn’t get anywhere near the amount of sunlight that we do, has a renewable technology centre, albeit that a lot of it is sponsored by the coal people, conscious money, then here’s a place which is in the highest solar-resourced area in Australia. And then I said to them, ‘Well, what about renewable energy for the place itself?’ It was not even a consideration, not even interested.

- It’s a good idea but they want to go big and they can’t get the money, so wouldn’t it be better to start off small and getting it going and getting it paying for itself? But, you know, a lot of the universities are not interested. I spoke to [redacted] from Murdoch University. She said, well, she can take students to Shark Bay, which is a lot closer, and say, because Exmouth is a little bit further on and it’s expensive, she doesn’t bring students here. She can do what she needs to do at Shark Bay. And I’ve got friends who work at the Tropical Museum in North Queensland and one of them was heavily involved in all the exhibitions and stuff like that, and he said the cost in keeping them updated is huge. And he said just the cost of keeping the whole place running is just huge. So not only do you have to get the seed funding to at least establish the place, then there’s a lot of money that goes into keeping it going. And I think they were hoping that government bodies might like DEC and Fisheries would put their offices there, but they don’t seem to be very interested in that.

- There was lots of meetings and really we haven’t progressed from a few years ago. And they did have a GDC officer based in Exmouth and the last one left because his wife left the Shire.I don’t think the position’s been filled. And if they’re having difficulty filling the position, then they’re more likely to just put someone in there just for the sake of filling it. I don’t know. But now there’s someone down in GDC in Carnarvon who’s sort of overseeing the research centre proposal, but she’s obviously got lots of other things to do as well. I’m a bit sceptical about the whole thing, quite honestly. I mean, the concept is good, I think very, very good but I think you’ve got government agencies and unless you can tie it in with the general facilities that all the government agencies will use it as well, I’m not sure if it can...

- If you have to charge exorbitant rates, which they’re going to have to, to pay for it, you’re not going to attract people because scientists can’t afford to do that. A lot of scientists come and use the bothy near Milyering which only costs about $20 a day or something like that. But it’s hard getting research funds and you certainly don’t want to spend those funds on accommodation and have no money left to do what you want to do. And [redacted] was sort of suggesting that they think about making the centre at the bothy a bit bigger but they obviously don’t think that’s a good idea.

- They put proposals forward to Cabinet but the trouble is Cabinet virtually said, ‘well, we won’t consider putting in funding unless we get federal funding’ and then the Federal Government said no. So that’s where it stands at the moment. They’ve just put forward a new, more plans and options in terms of what they want – do you want it to be this sort of facility or this or this, and they had a workshop that I couldn’t get to. So I just need to see what the outcome of that was. It’s not costing them anything to have me on the committee because we’re all volunteers, we don’t get paid, the only cost is if you’ve got someone on the committee who flies up from Perth

- I think if you have like a desert museum there as well, like a desert park, you wouldn’t have enough land there to set up a desert park. If you could coordinate a whole lot of things that would bring the general public in, it would help to pay for it, but you need a good concept for a visitor’s centre. It’s getting harder and harder to generate those funds and that’s why I thought well, if you also promote it as a multi-functional or multi-faceted, so it’s not just the marine environment that you’re targeting but it’s also renewable energy, wind and solar, and have that sort of research facility which will bring in the money, and they said, ‘Oh, that’s a good idea’ but they don’t seem to have pursued it.
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• When they were ‘let’s get some iconic person to be the sort of patron, somebody that’s well known in Australia.’ they came up with people like Elle Macpherson and people who are really not known for research. I said what about trying to get Tim Flannery on board, and they went, ‘Oh, that’s a good idea’ but I don’t think they’ve pursued that either.

• Definitely, the research centre would be a conduit that you could use for this research stuff, but at the rate it’s going, I can’t see it happening in my lifetime. Some of the people on the committee are very much marine-oriented among some of the universities. It’s a good idea but I just think they’ve got a blinkered view. As I said to them, I said, by having...I think if they did a survey of the people in town and found out what they knew about it and whatever, I think most people would think that it’s going to be a marine facility. I mean, it’s got a whale shark logo, what does that tell people? And I just think they need to get away from that. Looking at the recent proposals, I couldn’t see anywhere in there that they were thinking anything other than marine and so basically what I’ve said has fallen on deaf ears – which I find frustrating. Ok, I am a marine person, that’s my background, but the Shire here does nothing to promote renewable energy, nothing, they don’t even have policies that says ‘you should have white rooves rather than dark rooves or dark houses’ and they certainly don’t do, as far as I can see, do anything to promote renewable energy. Ok, most people have solar hot water but in terms of anything else, it doesn’t happen.

2 Issues with government

2.1 Lack of real consultation

• On Government side, the mode of inclusive decision-making and outward communication could be better. There’s a culture of lack of inclusion and black box consulting.

• There’s a culture of black box consulting and lack of inclusion. [What do you mean by black box consulting?] Research is undertaken, findings are considered, management planning occurs, 4 years later a management plan is produced which is put out to the community with ‘This is how it’s going to be from now on’ and here’s a week for review/comment that won’t change anything to the outcomes anyway. Landholders and managers spend significant time and resources to seriously consider draft proposals by Government and provide comment thereon – not having had any forewarning that these processes were going on or about the information that fed into the processes. Landholders and managers invest commercial time and money to provide comment on draft proposals by Government, but nothing ever comes of or changes as a result of such input. The Government proposals stay the way the proposals were the day they were written. It doesn’t work on the ground. It’s not hard to say to people, ‘Here is the findings of the research. We’re going to prepare a management plan. Here’s a draft. Is this the way things play out on the ground?’ And then landholders and managers can provide feedback on priority issues on the ground.’ Include people and the on-ground information they offer if you want to maintain faith in process. There is no faith in process. It doesn’t work. It’s an ‘us/them’ approach and people on the ground are simply told how it’s going to be with no real inclusion in the decision making process. Yet the landholders and managers on the ground are the ones who have to deal with issues practically, day-in/day-out, year-in/year-out. But they’re seen by Government as the enemy.

• Part of the reason that the Ningaloo Reef environment can be so explosive is because, and I’m not necessarily saying that the majority view should always rule, the view of the majority needs to be better canvassed and included because people once won-over become your environmental police on the ground - if they believe in what’s being done and feel included. Even when the message is one that didn’t at first accord with views traditionally held. You can deliver a hard message as long as you can back it up, but not if it’s done in a dictatorial or arrogant way. Obviously the commercial tourist operators, some locals and visitors would like a more permissive environment. But we have to bear in mind that the Ningaloo coast is a national asset which warrants protection through responsible use and behaviour.

• It’s amazing to be asked, ‘What do you think the model could be used for? How could we use the model or make it more effective?’ Our biggest issue and what we say to Government is, ‘All we want is to pitch our issues and point
of view for consideration and inclusion in the decision-making matrix’. Government has to consider conflicting priorities, resource constrictions and political reality prior to a decision. We don’t insist or expect our views to hold the day but would like them included in the decision-making matrix prior to decisions that greatly affect outcomes, direction and our daily life on the ground. We get really unhappy when our views aren’t even put into the decision-making mixer. Let’s put these views into the decision-making mixer and start mixing. It’s all going to be watered down significantly anyway, but the problem is your views are not even in there before it starts being watered down!! The people on the ground are impacted the most by the outcomes of the decision-making process, the whole day, every day!. We’re the ones who pay for your decisions. When you get it wrong, we pay.

• A 5 minute conversation with a very senior person in a Government organisation is worth more than 12 months of ‘consulting process’.

• Government does their balancing acts and ultimately decides. That doesn’t bother us, that’s how it works. But, let’s really canvas all the views and issues and drop them into the decision-making mix. At least let all the views and issues be considered before they are discarded. At least run them past the senior person / team in charge of the process. It is not necessarily a problem if they are discarded by the senior person / team upon consideration, but if it is never put in front of them, there isn’t even a chance that they could go ‘hmmm, put that there, we’ll bear that in mind’.

• And that way, if it’s a real consultation and not simply black box, then you’ll have the ordinary man on the ground, the landholders and managers possibly regaining some faith in process again. Because at the moment consultation and process is simply seen as stepping stones for achieving predetermined faits accomplis that were discussed and decided in Perth behind closed doors. Locked in and then people just get told how it is.

• I don’t believe whatsoever in consultation. Consultation doesn’t exist. It’s just a box to tick. It means nothing. That’s researchers, Government agencies, NSDO, across the board. Consultation is a myth. Definitely in Western Australia.

• Like the Management plan. We prepare a report – again, it’s not an emotive four pages of how my father was born here and why we should be entitled to this, it was scientific report – and get it to them by the closing period for consultation. We ring the day after and ask, so what happens with our comments now, when are they going to amend the management plan. They say, why, nothing, we’re not going to amend the management plan, we just wanted the comments. But we didn’t leave it there.. The issue has been coming and going as the World Heritage issue comes and goes. You can imagine going through a management plan this thick, the whole thing, taking the time and spending the money involved in doing that, to be told, ‘thanks for your comment, we’re not actually going to include any of this, it’s not going to change the management plan because we’ve written it and we know it’s right’.

• There’s a management advisory group. But that’s the thing, if you’re not on it, you’re not in it. I daren’t not be there.

• But my only real concern is the lack of inclusion...your answer is that’s solved by consultation...but I don’t know, only if the consultation goes further than consultation – actually taking comments on board.

• With the Vlamingh Head draft master plan, a lot of work went into preparing a really detailed submission for that and they actually took a lot of what we said on board and it was absolutely fantastic. But that’s a rare thing. A lot of the time you put a lot of effort into the submission and there’s no feedback, there’s no follow up, there’s nothing. There’s not even a follow up letter when the report comes out, saying ‘Here’s the final report, thanks for your input.’ There’s nothing. That’s where the Ningaloo Sustainable Development Commission was different because they took stuff on board! They really did! And actually DEC has taken our stuff on board but that kind of makes sense because we are all in the same movement.

• But we have no inclusion by Tourism WA whatsoever. There seems to be a policy across the board with all the agencies - it seems to be directional and it’s probably a satellite direction from Perth. It seems that if you’re sitting drinking coffee in Freo, you’ll have more say about what happens up here than those who live and work in the area.
[So you feel that locals don’t have much control over what goes on here compared to people in Perth?] Not at a strategic level. Obviously on a day-to-day level, yes, but not on a strategic level. What we do on the ground would be completely passed over by the perception of the café culture in Perth.

2.2 Red Tape slowing development

I’ve been here for 30 years, [_____] has been here for 15, and the population in Carnarvon has shrunk in 15 years. There is no growth because you cannot get through the red tape for development. If you want to develop anything on the coast, it gets environmentally bound up in red tape by DEC and the greenies, and that it is scaring investment away. If I had a spare 5 or 10 or 20 million bucks and I was going to have to go through all that kind of rubbish, there’s a lot of other places you can spend your money without having to deal with all the red tape.

They say, ah, we’re getting overcrowded, quick, we’re going to have shut Coral Bay down. The only reason you’ve got to shut Coral Bay down is because they didn’t allow Maud’s Landing to go ahead and put infrastructure in. It’s catch-22, you’ve got government departments fighting government departments, and private enterprise is just getting flogged along the way. Because the longer we wait to put money into the coastline or make money on the coastline, the worse off we’re getting. It’s costing us money by not developing the place. The Gascoyne is on a decline and it has been for the 15 years we’ve been here. So, you know, I sort of hope this comes through with a bit of something positive out of it.

2.3 Not considering triple bottom line

I was in a meeting recently and it was said ‘Money is dirty’. This concerned me as issues need to be considered on triple bottom lines. There has to be not only environmental and social streams but also an economic stream. Conservation needs to pay for itself or in the long term it will be judged too expensive and limit positive outcomes on the ground. We must maintain a balance. Without money there is no environmental management.

Everything is environmental. It is just purely 100% environmental, and that just doesn’t work. It works if you’re sitting in Perth and you’re trying to get votes from the minority groups, well and good, you’ve done a good job. But as far as the regional economy goes, it’s absolutely stifling.

Proposals for land use development must be considered on triple bottom lines before development approvals or ‘go-aheads’ are given. Agencies like Tourism WA remain bullish in its approach to development of the Ningaloo coast and dismissive of the need for any prior triple bottom line consideration or assessment of the appropriateness or otherwise of proposals. The attitude is ‘Just get it in and deal with impacts later’. This approach does not regard the legacy impacts of proposals which may be irreversible. The primary issue needs to be protection of the Ningaloo coast as an important national (and global) natural asset and iconic destination – much like the Great Barrier Reef but ‘undiscovered’. There may be a need for improved visitation facilities, such as waste management along the coast, but proposed significant changes must be first carefully considered given potential associated adverse and irreversible impacts. For example, the damaging increased pressure on fish stocks from recreational fishing being facilitated by the ill considered and politically pushed new boat ramp in Coral Bay as well as the canal development in Exmouth. No prior environmental impact assessments or strategic impact assessments were undertaken of these developments which is very poor practice. That’s why there remains little faith by ordinary people in process.

2.4 DEC

As far as DEC go, ok, you’ve got to have some national parks but their whole management theme seems to be to lock up whatever they’ve got and stop people from going there. You’ve got WA Tourism sending people up here to the Coral Coast, the greatest bit of coast in WA, but then you’ve got DEC saying well, no, you can’t camp here, you can’t have a fire, you can’t do this, you can’t do that, and they’re turning them away.

When it comes down to it, if the economics are good, you’re going to be able to spend money on environmental – unless you are DEC who is just a black hole: they don’t raise any revenue, they don’t pay rates to the Shire, and all they do is they stick their hand in the government coffer and just say, ‘We need another 5, 10, 20, 40 million dollars to keep running’. So they’re not doing anything for the regional economy, and that has a direct impact on the social
and economic side of private enterprise, which then means the first thing that’s going to go out the window is spending money on environment. I mean, you’re going to feed yourself before you’re going to save the turtles. They are such big issues not have in the model. I’ll take it up with when he gets here.

- It’s amazing, and just anecdotal, the amount of people coming in here worried if they can bring a dog or light a campfire or get to the beach, because they’re so used to DEC’s regime. And I, not that I laugh about it, not at all, but the fires they’ve had up at Karijini, there’s no grazing, there’s no firebreaks, there’s no way to slow the fuel load down, so when they do have a fire, it’s a ripper.

- I think DEC are a major obstacle purely because they are only environmental bottom line and not triple bottom line. They are a threat to the regional economy. They don’t contribute, as far as the bush goes; the problem that we’re getting back in town is that the social infrastructure’s going and you don’t need supplies in town anymore because there’s nobody left in the bush.

### 3 Pastoral Stations issues (& background)

#### 3.1 Issues with 2km coastal strip

- By taking a 2km buffer zone down the coast, you’re going to make four pastoral leases (because the black fellas don’t count, they’ve got their freehold in Coral Bay now, did their own deal with the government) unviable because you’re taking out the most productive part of the land, which is the coastal strip. All your watering points, all your freshest water, are along this coastal strip; removing it is going to make four stations unviable. The rest of the pastoral leases then aren’t viable.

- I can see where politicians and bureaucrats are going, it’s only four stations, no problems, but what you’re doing is you’re taking another million and a half/two million acres or more out of the pastoral range lands industry. The more of land that they take, the more social infrastructure they’re taking out of it.

- At the end of the day it might just look like four stations along the coast but that actually eats into the whole pastoral industry and then eventually into the regional economy because if we go, and a few stations up Gascoyne Junction go, and they take a few more stations away from the Kennedy Ranges and Mount Augustus, then a few more stations up in the Pilbara, suddenly you’ve lost a whole heap of social infrastructure and the towns will be affected. Now it might be alright for the Pilbara where there’s iron ore flooding out, but once you get down here into the Gascoyne and further south, it’s going to decimate the regional population. But then you need to start looking at is small business relevant? I mean, you look at the way that agriculture’s going now, you’ve got companies buying 5 or 10 million acres to run economy scale herds.

- Tourism modelling from Curtin, that’s nice, but currently we don’t even know whether or not we’re going to be managers of the coastline. My current understanding of negotiations and the way the pastoralists are talking is that is assuring them that he will be extending their leases or they will be managing the camping along the coastal strip. Completely different model from where we’ve come from. If they do, I would say to the NSDO, go organize a meeting with, with and ask them how they would like to use the information, because they’re the ones who are going to end up managing it, because as an agency we’ve only got the 40m. As we’ve always said, with that 40m we can’t do bugger all if we can’t manage what happens behind it. Because we have no control over that. And that’s why we’ve been in a stalemate situation along that coast, its because there’s very little limited stuff we can do unless the pastoralists work with us, but they don’t want to work with us. Or they see working with us being us doing as they ask.

- came up one time, when all this coastal exclusion stuff was going on, and he laughed and said when you hand this land over to the government, I’m going to come cut your fence and there’s nothing you can do. He’s not even a bush guy and he’s worked this out. Once they realise that we don’t have any control, they’ll stop and camp where they want and say ‘it’s not your land, you can’t move me from there.’ He really put into reality what was going to happen here.
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• The personalities you’re dealing with [on the pastoral stations] - I can’t even put signs up without them wanting to change the wording, the colours. I’m trying to tell them these are standard signs; I can’t customize and change them.

3.2 Lack of trust/cooperation

• Pastoralists wouldn’t pay for advice and services from environmental professionals if they just wanted to mine sheep and flog the land. There’s change in the air. Pastoralists see themselves as rangeland managers now rather than stock managers – evidencing a phenomenal change. The rangeland condition is paramount.

• There needs to be a shift from the ‘them/us’ mentality towards an attitude of ‘we’re working together to solve this problem and to protect something we all care about and love’. The public and the landholders/managers are not the enemy. They want to do the right thing too. Everybody loves the reef and it does a disservice to environmental protection when there is so much breakdown in communication and continual distrust. There’s just no cooperation, from both sides.

• [Do you have any thoughts on what could happen to start to break that distrust down, particularly between the pastoralists and agencies?] I think it’s very simple and not that hard. Include landholders and managers in decision making, in what’s going on, what’s coming up and afford them a real opportunity to participate. Do not simply have a ‘black box’ consultation process where the outcomes are pre-decided and already determined. Then trust that landholders and managers are intelligent and responsible enough to assimilate this information for changed behaviour and actions on the ground as a result.

3.3 No understanding of pastoral operations

• We get a lot of criticisms from people who come through – ah, you have too many sheep, you have too many goats. They’ve got no idea how many goats are here. They’ve driven in the main road, gone down to  and they’ve seen a few goats. They have no perception about where the waters are or where the feed is or what’s going on. But they just have to go back to a Perth agency, say we’ve got a problem with that, evoke the EPBC Act, even though there is nothing untoward or wrong in the first place. I remember  telling me that some woman came to his shop saying, ‘You should be ashamed of yourself, you’ve chopped down all the trees’. But all it takes is someone like that to go back to where they came from, put an email into the EPA, and bang! They have to investigate it.

• It’s a different way to live up here. To survive up here is completely different to what happens down south. And that was one of the reasons why I said to  you want to do this job, you come and you live here. And you get to see the seasons, you get to see what’s involved, you get to see the people who are coming through. Then you get a bit of an appreciation for who and what you’re dealing with.

3.4 Managing visitors on pastoral lands

• We do more DEC work here than DEC does.  who works in the shop goes for a swim out there everyday, and she does ‘DEC’ work every day. When the visitors come in, she tells them ‘here’s the fishing guide, there’s the size limits, there’s the bag limits, there’s the sanctuary markers there… the visitors are given all this information by us, but what happens after that is we still have to police it. It’s well and good putting in sanctuary zones, but why, if you’re not going to police them. And the same with illegal camping up and down the coast. That’s a 3/4 hour run if you have to pick up illegal campers south of Three Mile. I got a phone call saying ‘illegal campers at Turtles’, it’s an hour and a half drive down there. And then you’ve got that confrontation between a lay person and illegal campers, whereas it’s easier for someone with a DEC badge to confront them.

• I spent three hours with a surfer with an axe. Yes. He was going to kill everybody and set the place on fire… it’s not worth it. But you’re going to get that while they have the attitude that it’s the beach and Australian beach is theirs. If it’s a national park, you’ll never stop them. Anyway, that’s what you live with. We put gates up, they drive through them. That’s just the way it is. When you hit the main highway, you’ll see there’s no Gnaraloo sign. There’s a space where it was. Apparently there’s been about 30 put up, but they take them away because they don’t want to share the break.
3.5 **Gnaraloo Road issues**

- We got that track to Gnaraloo closed, it’s only closed temporarily for another 4 years, it’s just been re-closed last year, because you cannot manage it if it’s through traffic like that, and not only that, it’s not a road, it’s dangerous. It’s a miracle there hasn’t been some fatalities out there — and you get a lot of these young people, they are sold less than roadworthy vehicles, they all know who to buy it from in Perth when they arrive, they pay $200, they’re young girls on their own, no idea, two wheel drive vehicles, vehicle vans, Wicked vans another thing, we rescue them all the time.

- **[But can you imagine if first they put in a road to Gnaraloo and then Gnaraloo Station to Coral Bay – right through]...** It would totally destroy it. They can learn from the eastern seaboard where there’s roads up and down the coast. They can learn from all around the Mediterranean and the Europeans have learnt that, and my understand is that all those rich estates that go right down to the coast and the Med, they are now, the government is now buying them back as they come up, as they go out of families. They’ve learnt. They’ve been down this road, for thousands of years before us.

3.6 **Need authority to enforce regulations**

- For 5 years we’ve been requesting to be honorary DEC or Fisheries rangers, but nothing has happened. And I would have to class us as good, we’re into protecting what’s here - some of the other properties wouldn’t be as environmentally focused, I would think. It’s just a dog on a bone really. ‘Oh yes, we’ll look at this. Oh yes, we’ve talked about this. Oh yes, it’s at the next committee meeting’. It’s just not going to happen.

- So on a more positive note, on Friday the new regional manager of DEC, a South African, was sitting where you’re sitting and we had the most wonderful meeting with him. He’s just been in Karratha for two weeks, he must have been head-hunted and just jettisoned from South Africa. That’s just my assumption. But he’s been in conservation all his life over there, so obviously far further advanced than Australia. And he sat here and he said, ‘What are the problems?’ And I said the problem is we’re managing the access to this precious natural resource, we’re toothless tigers, we can’t do anything, we ring up Fisheries and say, ‘Listen, there’s 10 blokes down and they’ve got freezers on the back of trucks and we know they’re meeting their mates out on the road and we know they’re selling them in Adelaide.’ And we can’t do anything. And when we tell Fisheries, they can’t go or they don’t go to that camp – so there’s either something more sinister going on here, I hate to think so, or the system’s not working. So straight away, he says, ‘Look, we’ve got this training course, you can be trained up as honorary Fisheries inspectors, we’ll give you some relief with your airfares and accommodation, it’s a two week course in Perth. Would you be interested?’ And I said, ‘Of course we’d be interested.’ We’ve been saying this for years! We’re prepared to train up in Conversation, Land and Management, Fisheries, whatever it takes. We’re passionate about keeping this.

3.7 **Warroora Station**

- The bitumen road goes through the middle of our property. We’ve got cattle on the eastern side. We’ve just finished fencing that, we just did 80 kilometres of fencing this year. And, so the sheep are on the western side and as you can see, there are no trees...it’s pretty wide open range lands. It’s one of the nicest pieces of coast you can come across, yeah.

- Yeah, well you’ve got the reef of course, you can just walk out to it. The snorkelling is absolutely magnificent because fortunately there haven’t been too many people come here, which is nice — as opposed to Coral Bay which used to be total paradise and now it’s totally wrecked, and that’s just the time that I’ve been in the area. That’s just in the last 45 years, totally wrecked. Boat anchors...

- We went out on a limb to buy this place. I didn’t have 100 dollars, I had to borrow a million, so my sons had to work for nothing for years, you know, and we did it deliberately because we thought if we’re on the ground here, we’d have some say in keeping 50 kilometres as Mother Nature intended it to be. So that’s where we come from. We’re not here to make a squillion dollars out of tourists or anything like that, but of course we have to be economically sustainable, but we think there’s other ways of doing that.
The only reason this place and the Ningaloo Reef itself is in such pristine shape is because of the isolation and the fact that it’s had pastoralist leases up to the 40 metre mark for over a hundred years, and there’s been no development. And the fact that it’s not intensive agriculture – we’re not putting fertiliser on the soil, it’s all clean-green stuff. And the rainfall isn’t like next door to the Barrier Reef where you get the wash-off. And we’re just lucky that mix all came together and we’re still left in the year 2009 with a piece of Mother Nature which is fairly well intact. One of very few places on Earth.

3.7.1 Relationship with Baiyungu People

- We've got a treaty with the Baiyungu people, the traditional owners, our neighbours to the north at Cardabia, and we're going to develop a walk, because we don’t believe in this driving past and cameras out the window. We think you've got to walk and hear the song of the land and listen to the stories. So we launched that on the 21st of April up at Maud's Landing, and we're developing applications to get funding for that, and we're absolutely likeminded with the Baiyungu elders on this mission. And we'll like to see that grow over the generations until it's linked up north and south.

- I'll just tell you one little story. I was camped out at Ningaloo Station with Ningaloo, Cardabia and some of us, all girls, and old [redacted] she's the main elder for the Baiyungu people, and she told us this story. There was a big mob of them walking down the coast and one of the ladies squatted down and had a baby, now this is 70 years ago, and all the men went into a huddle and there was much talking and gesticulating. Then the main man came and said to the ladies, ‘Ok, that's it, you've got to leave the baby here, we're not going to be held up with someone, you know, looking after a baby.’ So the women all started wailing but they had to go because that was the rules. The men were in charge those days.

- So when they camp for the night, this is down in Quobba, [redacted] old auntie, she snuck away and she ran all the way back and she found the baby and he was covered in ants and she washed him off in the ocean and [redacted] said, ‘That was my grandfather’. Anyway, [redacted] had this old black and white photo of this old Aboriginal lady, and she said, ‘This is my auntie’.

- So what we want to do, we want to just have these mulga poles and we want to use technology and have a chip in there so that will tell the story. Not just of the Aboriginal heritage but of the pastoral heritage. We've got wells out there that are just carved out of stone, that's why they built the homestead down there. And there's all of these stories and that's what we think the visitors want to hear. They don't want more of the same.

- They want to know, you know, this is the place where the young 16 olds Croatians whose boat The Stefano hit black rock north of here and sank that hit Black Rock out there and swam ashore, and 14 of them perished in a cave just down here...

- Well, Gustav Rathe, who wrote “Wreck of the Barque Stefano”, was the grandson, he came out and launched his book at Exmouth. My brother and I organised it. And he came down here and there's a 200 hectare dune blowout down there, he said we're within one mile of where that cave was where they all perished. But over the years, more than a hundred years, it's grown and the cave's obviously under the sand. So there's that, a major story, so when you come across this bush with the little red berries that Mum and I picked up only a few months ago, this is what the Aboriginals taught them to eat. This sort of thing, you know. There's a richness, there's a lot of layers.

- Well, the last two that were just on their last legs down here in the cave, that's when the Aboriginals came along and they were the Baiyungu people, [redacted] people who I just told you about, [redacted] grandfather. They took them, it took 6 months and they walked them around to Bundegi, the tip of the North West Cape, and then Wilson Tuckey, who's been in the news a lot now with the climate change, he's over in Canberra, his grandfather had a ship and he rescued them. He took them back to the old Yugoslavia and the priest wrote the story of their amazing tale. He wrote the journal and Gustav Rathe who lives in the States now, he's died since, he wrote this book. But the actual package, the real journal, that's what you've got to get a hold of.
3.7.2 Warroora Visitors

- We’ve got 50 kilometres of the coast and we’ve got a variety of interest groups, the largest interest group is the retirees from the southwest – not necessarily just the southwest of Western Australia but the whole south of the nation. And we get a lot of eastern states people pulling their caravans across the country because there’s nowhere like this that they can go and have an affordable holiday, they’re all on pensions. So they come and they all prefer to camp in one area which is called the 14 Mile. The attraction there is that they can all camp on the beach and they’ve all got little tinnies and they can launch. It’s all lagoon country and it’s outside the sanctuary zones.

- And they have a whole social structure, there are repeat customers and they all know each other. They have like an annual general meeting down in Augusta at Christmas time...and they have bocce on the beach. And they have lots of fundraising things and raise money for charities and then they have their little drinks at 5 o’clock and there’s a whole social structure. They walk a lot. They’re a great asset because they think it’s their beach and because they’ve got this feeling of ownership, they hate any new people coming, absolutely hate it. But what they do is they sort of act like caretakers for the resource. The positive that comes out of that ownership thing is that they become vigilantes, they’re constantly walking.

- And it’s a huge asset to the health system in the State. Down in the southwest it’s cold, they’re always at the doctor’s office. And up here, because of the weather, they get much healthier namely because they can get out and they do a lot more exercise and they eat healthier, they eat a lot of fish.

- So there’s that crowd and possibly we can have in the July school holidays when that coincides with the family groups, you can have up to 100 camps, with 2 people in each camp. But then from there, there’s a long stretches when there’s nothing and there’s a place just up the road here called Steven’s which is a popular surf spot. So that’s a different clientele. There’s one at the south boundary which is a surf spot and there’s one at the lagoon that’s a surf spot. But the lagoon is also popular with family groups because, you know, there’s a salt water inlet and the children have got something to do. Then there’s a stretch called Black Moon Cliffs which is Baiyungu country and that’s got isolated campsites on it, to cater for people who like an isolated site when people hate being next to somebody else. So we try and cater to a diversity of interest groups. But we don’t want too many numbers, you know...

- Naturally there’s going to be more and more numbers all the time, but what we prefer to do would be to build up the infrastructure back here, at the homestead complex. That’s the way I’d like to see it grow, so that you don’t ever compromise this sense of wilderness – after all, that is the attraction, the sense of wilderness. Although you can’t get the government to recognise that. They want to carve up parcels of it and put $600 a night beds and tents on it. When you’re on the ground and you see what the globe’s looking for, the globe’s looking for a place to jump off the merry-go-round and learn the history and feel it, you know? They’re not looking for this. There’s a million places they can go to have that sort of experience. That’s what we find with the Europeans anyway. And we get a lot of young adventure Europeans and the interesting thing about them, of course, is that they’re trying to escape the northern winter. They come in the summer months when there’s no one here, so it’s a good balancing act, and they don’t mind the heat. They love walking and swimming and snorkelling. They’re much more prone to those passive sort of activities.

3.8 Quobba Station

- And the increase in population, which is no doubt in your data there, in the last 15 years, I mean, 30 years ago we used to have people turn up just to try and get a shower. A dollar a night to camp here when my folks first took it over, and if you saw half a dozen people in a fortnight, geez, you’re going pretty well. Now if you don’t see half a dozen people in a day, it’s an exception. So obviously it’s the marketing and the promotion of the Coral Coast, and the urban sprawl, the population, there are just more people on the road. It’s the perfect opportunity but it comes back to red tape.

- What are they talking about, 35 or 40,000 or 40 million people here in Australia by 2030? That’s almost doubling. I think we’ll be fairly right here because we just don’t have the rainfall, we don’t have water, and you’ve got to have water. This piece of coastline on Quobba will never be wrecked because it’s just hard limestone. But the fatalities
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will go up because you’ll have more people here. The majority of people that do get washed off by waves, they’re fishing in a big swell anyway. There might be a 3 metre swell but if a 4 metre wave comes through and they’ve got their back to it, they’re in the drink, and then of course you can’t get out. What have we had, about 24 since the folks have been here, all in 31/32 years. Fishermen or tourists getting too close to the water. The problem is we’re the first port of call so we always get sent out there to pick up bodies or search for people.

• And that’s another problem with tourism, it’s a 24 hour enterprise. We don’t have to advertise, we don’t have to promote the place because it just draws them in like a magnet. So it’s no good fighting it. Get on board and take it to your advantage. But it takes its toll. All this planning stuff is just ridiculous.

3.9 Nine Mile Camp

• I’ll use Nine Mile Camp as a classic example of relocating people due to environmental impacts. Last year there was a major dune blow out due to the fact that a camper decided to dig a trench through the dune to release water after flooding. At Nine Mile Camp, people camped on the flat area behind the dunes. As a result of him doing that the tide’s swell now floods that flat land. The end result was the campers shifting their tents not to higher ground but closer to the beach, on to the dune, digging their tents into the dune system. Major, major dune blow out and environmental damage at its best. And all that water coming in, it unearthed all of the rubbish which over years and years had just been buried in the sand, and I’m talking stuff from the early 80s, like those little buddy bottles of Coke with the foam covering around them. And so close to the marine environment. Hundreds of these sorts of cans, bottles, plastic bags, buried in the ground – which, I suppose, highlighted to us the importance of waste management. So as a result and in discussions with Cardabai Station and others, it was agreed that we need to rehabilitate that dune, we need to keep people off that flat area, we’ll call it the mud flats, because ultimately it’s not an appropriate place to camp – even though historically that’s where everyone’s been going. Me and my family included.

• So this year, bollards were put up and closures of tracks were put in place in consultation with the Station owners. Information was put out in the form of flyers etc to say this area is under rehabilitation, therefore all camping needs to occur in two different locations – one being in a corner at Bruboodjoo, stable ground, and the other east of the main track into Nine Mile Camp. As a result, there’s been a lot of animosity from the campers towards DEC and the station owners because they don’t particularly understand the importance that these dunal systems have for the coastal environment. So their main priority is, I’ve been camping here, I want to camp here, this is where I have camped, why now do I have to go over there? So that’s caused a lot of issues.

• Let’s say 30 caravaners/30 campers are now pushed to a different location. Still incredible views, probably even better than what they had behind the dune because behind the dune they have no views of the ocean. So we’ve put them up to higher ground, we’re only talking 150 metres difference yet there’s major complaints. That’s firsthand experience – and that was even me down there with our senior ranger last week, coping abuse not directed at us but in a roundabout way, as they say, “The indigenous people are making us do this, you guys, DEC, need to do something about it.” We then let them know we can’t, it’s not our land, we don’t manage this, we manage up to here – the 40 meter strip above high tide mark. But as a good neighbour policy we are supporting them in their request and they’re supporting us in our request not to allow camping here because of the fact it’s not sustainable, and look at the damage that’s been done and the waste. There had been a lot of animosity from day one, even though we had promoted and made contact with regular campers we knew to pre-warn them and say, ‘listen, this year you won’t be able to camp here’. And we pre-warned the caretakers who have come up for the last 8 years, to say, ‘listen, these are the reasons, this is what’s happening’. Very disgruntled, not very happy, couldn’t understand.

• It came to a head when a group of other pastoralists from other stations from way inland came in and said, “No, we’re not camping here, we’re going to camp there, we’re well aware of legislation that says DEC only manages up to the 40 metre mark so therefore we’re outside the 40 metre mark. We will camp here, and if the station owner wants us to move, they can tell us to move.” So we then we have these caretakers and the other campers going, “Hang on, if they can get away with it, why can’t we?” We went down there, we talked to these guys, great guys, very understanding. They stood their ground, and rightly so. We as a Department didn’t have any authority to say to them “you need to move…” So we spoke with the station owner and said, “a lot of this will come back on you
because you now need to make a stand to say, ‘we’ve made that decision’ and stick to it. We’re not aware of what his decision is. He was going to think about it. So that's two different messages coming across.

- This is an example for the whole coast: whether it’s managed by the state or whoever, are these places in the right area? – if they’re not and we relocate them, what will the impacts be? We’ve seen firsthand that it’s not a good situation, like at Nine Mile. I’ve camped there for years as a kid… I stand back now, being educated on environmental issues, and I say, of course, it’s way better to be up here (Higher and more stable ground). It has better views but for some reason historically they do not want to shift from the dunes. I think it’s a matter of ‘I can just walk to the beach’ even though it’s only a difference of an extra 100 metres. So there’s this whole historical convenience issue. It’d be interesting to find out how you tackle that. This is the classic scenario which operationally and on the ground as managers you struggle with.

- [it’s hard weighing up whether the environmental outweigh the social repercussions.] Exactly right. Those comments were made by several campers, saying, why don’t you let this half kilometre stretch at Nine Mile go, look up there, look down there, it’s all pristine so why don’t you just allow this little area to go – let it deteriorate. Sure, but, in the same breath, the dune blowout still created a lot of issues. It’s going to create this inland creek system which has never been there before. But you’re right, weighing up that social aspect with the environmental is a classic argument, and one that needs to be looked at and considered.

4 Shire issues

4.1 Funding for Shire services

- All the documentation including this document here, the Local Government Structural Reform for the Gascoyne, considers us as a town of 2,000. When you go out there now in tourist season, there are over 6,000 people here, and that’s who we’re servicing. 6,000 people for 6 months of the year, not 2,000 for 12 months of the year. All our grant commission funding and similar funding we get to run the Shire of Exmouth is based on a population of 2,000.

- We’ve got the infrastructure of the boat ramps, remote toilet facilities, remote coastal bins and fish cleaning stations - all these services that tourists expect to have - but without the money to provide it. So for our rate payers, our general rate per property, it’s probably on the highest in the state. You also look at the ABS stats - because we are a tourist town, we’re not a Port Hedland or a Karratha, the wages here are one of the lowest in the state. Because the hospitality industry, our tourism industry, is one of the lowest paid. So you’ve got all this demand for services from the Shire with a very limited rate base.

4.2 Remote rubbish/fish cleaning facilities

- I deal with waste management in liaison with the manager of engineering services. I’m of the view that we shouldn’t be having bins in car parks on the west coast. If I go to the beach with an esky with sandwiches and drinks in it, I walked onto the beach with the esky, I’m going to walk off the beach with the esky, why do I have to stop at a bin and put rubbish in it? I don’t see the need for any bins around there, and I don’t know whether the research program can deal with those sort of issues.

- The Shire provides a 7 day a week service, 360 days a year, servicing 3 fish cleaning stations and emptying bins in these public car parks. The fish cleaning stations are one matter, maybe they should just go, or maybe not, but the servicing of the bins – they should just be taken away. When we did take them away apparently, there was a lot of rubbish being dumped in the car parks and the guys were spending just as much time picking up rubbish in car parks as they were emptying the bins so they thought it was better to put the bins back. I don’t think they kept the bins away for long enough, they only had them away for about 6 weeks and then they put them back in ‘cause they had to pick up rubbish. I just can’t get that mind set of people, that if there’s no bin, they just throw the rubbish on the ground.
4.3 Tantabiddi boat ramp

- The other thing is the Tantabiddi boat ramp. The whale shark operators and those sort of people pay DEC significant sums of money for their marine interaction licences and it goes down on their licence that they use Tantabiddi as their launching facility. But it’s the Shire that does all the work maintaining the bins, ablutions, car park and everything else. So how is it that DEC can take all this money for licenses and advertise that Tantabiddi is your base? DEC gives them a licence to operate from Tantabiddi, and when they come in off their boats they dump three or four large garbage bags of rubbish into the public bins, yet who services the bin? The bins are overflowing and the rubbish ends up in the bush – who’s cleaning it up? Answer to both questions is the Shire. Again I think the bins shouldn’t be there and the operators should bring their rubbish back into town and put it in their own bin or take it to the tip and pay tip fees. They’re the sort of things where the Shire is left carrying the can when other agencies are collecting the money from those commercial operators.

4.4 Road maintenance/station access

- There are some issues with one of the stations… they take a substantial amount of money during the year from people camping on the coast for what they call an ‘access fee’, and then expect the shire to maintain the station access road. That road is now getting hammered by big 4WD vehicles towing caravans and boats, yet it’s supposed to be a station road, servicing the station, not a tourist facility. So again, there’s this knock-on effect of tourism…

- In relation to the fees the station collect, they call it an access fee, yet the station charges people per head per night so it’s really a camping fee, but they don’t call it that. If it’s an access fee then why isn’t that money going back to maintaining the access? Why do they write letters to the shire and hand out standard letters to all the campers., over a month’s period we received a great pile of letters that were all the same standard letter complaining about the state of the station road and demanding that the Shire of Exmouth better maintain the road. So I’m assuming someone developed the standard letter and campers put their names on it and sent it to the Shire complaining about the condition of the road. But who’s getting all the money from the campers? Not the Shire.

- Many years ago the Shire did have a very expensive program of upgrading that station road. Then a new CEO and a new manager of engineering services started looking at things and thought well hang on, why are we doing millions of dollars of work on the station access road, why are we doing this when we can’t afford to do reseals on our town streets, our rate payers’ roads? So they decided to pull our resources back into the town and maintain our infrastructure in the town centre instead of worrying about one rate payer down the road. Since that decision was made there’s been more road resealing done on our town streets in the last 2 years than there has in the last 10, principally, I think, because we’ve diverted dollars and the man hours from maintaining the gravel station road.

- I think there was intent many years ago to look at making Yardi Creek Crossing an actual concrete crossing and formalising that connection to make a ring from here through to Ningaloo Station. I think that’s why 10 or 12 years ago there was a concerted effort looking at the access road to Ningaloo Station. But then following the outcomes of the Ningaloo Sustainable Development Commission’s Ningoloo Coast Strategy everything was downgraded, ‘these State Planning plans gave direction that, no we’re not going to open up the coast, we’re not going to have concrete crossings at Yardi Creek, we’re not going to have a highway along the coast.’ So after that sort of decision was made the Shire thought, ok, why are we spending so much money on Ningaloo Access Road?

5 Park management issues

5.1 Facilities vs impacts

- We go out in the park on a daily basis and I get a lot of feedback from the rangers and others on what’s going on out there. We know that camping is maxed out, ok lets open some campgrounds. Well, what’s the impact of that?
If it’s crappy weather, what will they do if they can’t go to the beach? Do we have enough day use sites, alternative recreational sites other than the ocean – which the majority of people come here for. Well, the answer is probably no. So we need to look at do they want walk trails and would they use walk trails in Mangrove Bay? What else would work, what else is there?

- From a parks and visitor services perspective, parks are for people so therefore allow them, how do we allow them in so it’s sustainable and it doesn’t have an impact etc. And also the balance of how many facilities do you actually put into a park before you wreck the experience.

- We’re allowed in the new management plan for Cape Range National Park to increase the sites up to 220, so double the amount of campers. Great. It helps with revenue, it helps with the frustration of people not being able to get in. It alleviates that problem but what impact will doubling the amount of people in the park have on Turquoise Bay, Oyster Stacks and Lakeside, which are really the only three areas that we promote for snorkelling. Will they become trashed? Do we now look for another area that we promote as a snorkelling site?

- Do we look at areas like Mangrove Bay and say, let’s give the visitor another experience. Let’s educate them at Mangrove Bay - beautiful mangroves, very important to the whole system - let’s build a boardwalk around so people can go around and look at the birds, read and be educated, and that will take people away from Turquoise Bay, Oyster Stacks and Lakeside for 2/3 hours. So we’re removing them but we’re just shifting the pressures. But it’s a different pressure.

- Or we can also say ‘why change it’, people are happy with it. If the park is full, it’s full, that’s it, end of story. How far do you go before you love the place to death? What’s that line? Where is that line?

- We get constant pressure from the Shire, from GDC, from whoever, you must, must, must, must… and then an incident occurs such as the deaths at Turquoise Bay. You must now put in a communications system, and you must put in life rings. But hang on, we’re a remote area. Is it reasonable and practicable to do these things because the coroner’s recommended them? Why don’t we actually do more education and say, you know what, if you can’t swim then don’t go in the water because you will drown – which has been the case.

- So at what point do you say no, this is it, and that’s the real struggle that we all deal with. How far do we actually go? Do we seal that road? Well, if I look at a rule of thumb, unless a road or track has more than anywhere between 50 to 100 cars a day, it’s financially not viable for me to seal that road. I’m better off maintaining it once a year with a grader than sealing it. Will that, by sealing that road, increase the traffic? Probably not, because the roads which are graded are two-wheel drive accessible anyway. So there’s all those different things to look at and that’s our big question – where do we stop? Where do we turn around and say, enough’s enough, the park is full, which is the case.

- Then you can get into the conservation issues such as Oyster Stacks. Yes, it’s low tide, shouldn’t really snorkel there, people do, so the staghorn coral gets broken off etc, they stand on it, etc. So what is the impact of doing these things and promoting it? Well the impact is negative to a degree, from a conservation perspective, but from a social visitor perspective, it could be great! Love Oysters Stack, love the little area you’ve done up there, this is fantastic! I’m not hassled by Turquoise Bay people with all their kids and families.

- Often I’ll go on to blog sites and read people’s comments. ‘Hey, go here, go there, the rangers don’t find you there.’ ‘Go to this snorkelling site.’ ‘Don’t worry about Turquoise Bay and Oyster Stacks, they’re too crowded and promoted but hey, we’ve found this great spot.’ Word gets out. I’m trying to keep up with what’s happening online… I’ll say to the rangers, hey, I really think you need to start checking out Mandu Gorge at the moment because there’s a lot of crew saying camp there because the rangers don’t check it. Sure enough, bang, there’s campers and wicked vans everywhere in there. So it’s using different forums to see what people are doing as well as observing what’s going on. And we’ve only talked about snorkellers and campers, how about sea kayaking, all those things…where do you stop?

- We’re going to develop Lakeside so these people camping at Kori Bay or Milyering most likely will go to Lakeside and take the pressure off Turquoise Bay and Oyster Stacks. We hope. Will it? Or because WA Tourism and the Shire and everyone else have so heavily promoted Turquoise Bay then no matter what you say, Turquoise Bay will remain in people’s minds forever, and that’s where they’ll go. Do we put a gate on the car park then to say,
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hey, full, sorry, you can’t go in? People are loving the place to death. Or do we manage it by opening other areas or developing other areas to take the pressure off? Will that work? Or do we actually speak to the Shire and to Tourism WA and say, you guys have got to stop promoting Turquoise Bay and we now need to start marketing Kori Bay, Lakeside. Stop with the Turquoise Bay, it’s too full-on. We’ve had deaths here; people are completely ignoring every warning. Yes it is, it’s very enticing, geez, it’s like a milk pond.

• Any increase is more people in the park, which is more impact on the park and the environment; do you continue to develop and upgrade and put in boardwalks and walk trails to guide them like sheep? Or do you leave it? And educational programs, hoping that people take on board not to walk through the dunes and let them grow. Maybe that’s just a part that people have to accept, when we provide paths, people stick to them, and we’re guiding them. But you get the other point of view from other locals or people who have been coming for years, who say ‘the place is wrecked’. We used to come here and there were no paths, I could go where I wanted to go. Now you’re telling me I have to use this path. Yes we are, because when you came there was only several thousand people visiting, now we’ve got several hundred thousand people. That’s that balance.

• It’s a struggle. At what point do you say no to development and providing new infrastructure in the park? Do you develop everything they want? People come in but there are only x amount of tracks going to beaches. Maybe eventually word gets out that ‘yeah, yeah, it’s good but they don’t have the facilities.’ Then conservation or the environment wins. But the town and the economy don’t.

5.2 Increasing visitor pressure

• WA Tourism, all those areas, anything to do with tourism impacts us [Cape Range National Park] dramatically. Ok, we can now accommodate another 5,000 people in the region, well, what’s that going to do to our park? With this amount of people now at the gate, we have a line of frustrated people because they’ve come to a national park and have to wait in line with 10 cars ahead. What if that doubles and now they’re 20 cars behind. What’s that going to do? Is our entry station in the right place? Is the system’s design set up well enough? Well, no, it’s not. Is it safe for our staff who experience physical, mental, verbal abuse? No, that’s not fair on them. Ok, so do we relocate it? Will government then turn around and say, well hey, it’s free entry to Cape Range National Park. Will those things be discussed? Is that a possibility that the state just says, this is what it costs you, here it is, ah, it goes on taxpayers whatever it may be?

• Ultimately people come here for tourism, no question about it, tourism, fishing, whatever, and of course the Shire and the region really want to improve and increase bed numbers, it’s great, triple bottom line stuff. But it’s the environmental aspect that often is compromised.

• We cop it, fairly or unfairly, I look at it and think, well it’s not DEC that are marketing this area. It’s DEC. Yet we’re the ones that cop all the flack trying to manage it. Hey, Tourism WA, how about you stop marketing the area? Well, they’re not going to do that. So you’re right, we need to work as a team and they need to be upfront with what they’re doing, their proposals and aspirations, just as we have to. We’ve got our agenda, we have to conserve these parks.

• I’m not marketing these areas. I’m not pushing and promoting this place for financial gain. It’s a few other government departments, and I’m not pointing fingers but it is, let’s face it. WA Tourism, they’re the guys that are all talking dollars. They’re the ones, it’s not DEC. So when that information about Turquoise Bay etc. is put out there to the public, people can see where it’s coming from. And it’s not to get the pressure of DEC, but you do feel it. I’ve only been with them for 7 years, but yeah, we cop a hiding. I’m employed to manage these parks for the public, not for me, not for my personal gain, for the public and for what’s best. And sometimes you get made to feel it’s your own personal agenda.

5.3 Management planning

• Do you think that rational approach to developing a management plan, do you think its created problems for you guys on the ground? I think it’s not sufficiently detailed from an operational perspective. If you pick up the Cape Range management plan, it gives us scope, but it’s specific enough to say what locations will be used for what. The Ningaloo Marine Park Management Plan only has sanctuary zones as spatial management tools. I was
involved in marine management planning and zoning over east; they’ve gone through an evolution similar to what I perceive in WA, which is they didn’t have management plans, they had zoning. Effectively all the zoning was dealing with was fishing extraction – again broad scale impacts, commercial fishing, where you could and couldn’t, mining, etc. That worked well in 1982 when the first zoning plan came into effect. Fast forward into the 1990s: Cairns from 40,000 to 120,000, plus a multimillion dollar industry from a 1.5 million dollar industry, every reef fully utilised. We’ve said: you can’t fish in that zone, but you can fish in there. Are we managing the area? No, shit, how are we dealing with all the moorings, what regulations are in place? In 1982 this wasn’t a problem. So they created management plans, which have details about the regulations required to manage these issues - what needs to happen where and how its going to be done. That wasn’t done here. They might ask how coral communities are rated in terms of threat: across the reef low, they’re not really under threat, however, in Coral Bay, in Turquoise Bay, yes there are problems. But because it’s a broad assessment across the marine park, the threat is low. The scale of the management plan isn’t consistent with the site specific issues we have to deal with. It’s not working.

- That also comes down to strategies which say we have to develop site plans. But that’s a whole new planning process, I have to consult with the community, I have to trade off values, etc. And the district is expected to do this. We need to say up front it’s not just about fishing…we dealt with all that. There’s also a regulation saying you can’t drive a 4WD on the beach without local authority – there’s still 4WDs on a lot of beaches – we haven’t gazetted any of those areas. Fires: there are regulations saying we must designate areas for fires, for dogs. We haven’t done it. None of that stuff was done in the management plan, yet the regulations and statutory frameworks are in place. We are meant to do all that here. How am I supposed to go out there in isolation? Again it comes down to trading off values. If we stop people going somewhere because of birds, it’s going to have implications on other areas. I’m making these decisions based on local knowledge, which I don’t have, because I only have broad scale knowledge. I don’t have site specific knowledge. Which I need for rationale and arguments, when I have to tell people we’re closing an area, but don’t worry mate because there’s another site 30 km down the coast. We say on Ningaloo Station, you can’t do that, we’ve decided that all happens at Quobba. They say piss off, this is our station, this is where we go, this is our playground, we don’t care what happens in Cape Range, we want the activity here. So the next level of management planning needs to deal with all these things.

- The department does site and recreation planning on a one by one basis, but they don’t do it across the whole park, in an integrated fashion, at the site scale. Cairns Management Plan and Whitsunday Management Plan did that. They applied a recreational opportunity spectrum to all their bays. We’ve tried to do that outside the park planning process for the last two or three years with [redacted], but it’s an impossible task because the consultation required to make it work can’t be done by one person. Effectively it’s a planning process. You need a management planning process, exactly the process that’s already been run. When you go ask people for their opinions, you don’t just ask about fishing, you also say this is where you’re going to launch a boat, this is where you can camp, and this is where…and it all feeds in. Because it wasn’t done, and you’ve got these zoning plans that sit over top of some key camping areas. Then you get the whole issue of people camping in these places but not being able to fish there. So at 14 mile Camp, which is an important area to protect for fishing, we get continuous breaches, because there’s all these people camping there. They can only fish in this little area here, which is overfished by far with the numbers of people camping there. If you’re going to put people in a place, you’ve got to give them something to do, or your going to have a problem. Or you decide to say that you’ll have to close these camp grounds. That’s the trade-off. And that’s the bit that’s missing in people who haven’t worked on the operational edge of things. I don’t think they actually get it because they haven’t dealt with the operational stuff they’re conceptual strategic people and they do that well, but you often get them saying “just close it” “just do this” and that’s where you get these bad decisions from Perth, that we’re always fighting here: they say “the turtles are there, you’ll just have to close it.” We say, “you can’t just close the local beach”. They say “well, you just put up a closed season notice and anyone who gets within 30m of a turtle, you book him.” So I’m going to book mom and dad with three kids on the beach? And the Act requires that I take them to court, because they’ve walked within 30m of a turtle? That’s the divide.

5.4 Visitor services planning

- I don’t think the pastoralists have ever been to Cape Range. They’ve never spoken to all the campers who go ‘this is beautiful, you can’t do this anywhere in the east, this is the spot’. They just get the negative, ‘ah, Cape Range,
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bugger that, it’s all got bollards’. Yeah, that’s right, it does, they love it. We’re catering to a group of people who like what we’ve done. Don’t bag us out because we’ve done this here, because this is what’s required up here.

- The visitor services planning process tends to be a forum for opening up discussions, and I think it’s the process that is critical in planning, even more critical than the final document. The problem with plans is they are so quickly out of date, it’s the process that makes things really happen rather than the product. Your interpretation planning you did at Shark Bay is a classic – everyone is still talking about it. I hope to a similar type of interpretive planning is done for Ningaloo – with more emphasis on communication.

- Identification of the values of an area and determining how they should be managed is the key to planning for visitors. The values are what attract visitors to the area and so need maintaining in the long term. Visitors need to become advocates for these values. Providing recreation facilities, information and interpretation to enable people to share, interact and enjoy these values in an appropriate manner should be the focus of planning.

- I don’t use the departmental process for planning, I use Stanky’s recreational opportunities spectrum for providing a range of experiences from wild to resort, each with associated management strategies. Where possible a range of opportunities for sharing each value are provided (eg providing 2WD, 4 WD and foot and walk trail access to the cliffs of Gnaraloo). This includes analysis and cross referencing of values and addressing all sorts of management issues and meshing issues and objectives together.

- Some agency people are unfamiliar with such planning frameworks, and people are concerned about the cost and time involved in this type of planning because of the legwork (research, analysis and documentation) and talking to people (visitors, scientists, researchers and managers) required – we’re dealing with big and complex issues.

- How [redacted]’s data will be integrated with DEC visitor planning is a question – not sure what DEC is going to produce. It would be good to talk to [redacted], to see what she is aiming at producing, and what formal processes she is setting up for long term gathering of data. We have ViSTAT that does visitor numbers, but going further than that I’m not sure. And I’m not sure how this links into research projects, or how their data will relate to what DEC does.

- Also working on Coral Bay Foreshore Management Plan, which gives some recommendations for detailed site design, infrastructure, etc. for specific sites at Coral bay such as Baz’s Park and the Coral Bay Marine facility, etc.

6 Coastal Strategy issues

- The Coastal Strategy needs such a huge overhaul because I think in the 5 years it was put here to first track development on the coast, the Red Bluff ODP went through, the Blow Holes ODP went through, and I think one up at Exmouth went through in 5 years. That’s three items in 5 years. You tell me the cost to the region as far as money goes.

- That [Coastal Strategy] absolutely has to be changed. I’ll tell you how it happened. I got my husband to drop me at the boundary fence, because I heard they were coming up the coast, 3 or 4 vehicles. So I’m just waiting, I’m just sitting on the fence so they had to put me in [one of the vehicles]. So we come up here, and they say, “oh yeah, we’ll have a node here. What they don’t understand is that after rain there’s a huge lake there, you know, there was no local input. We weren’t allowed to get in and I had to absolutely sabotage them, and they did too further north. It was just closed book mentality and not harnessing any knowledge from the ground – which was crazy, you know.

- They even followed it up, after this rush fly-by thing along the road. The Tourism Commission brought [redacted]she’s Dick Smith’s daughter, and her husband, here. They were sitting right here, a young couple, and I said to Mum, ‘You better get on that gold phone upstairs and make a call to the man upstairs to get it to blow gale force, we’re going down to look at this eco tourism site at Elle’s Beach’. So we get out there and all our prayers were answered and it’s blowing gale force and this young couple said, ‘oh no, we’re not interested in developing here’. They’ve done all those big-time things over at Lizard Island. So they went to Kangaroo Island they just developed up there since this happened. Not to even go into the science of how fragile some of these places are.
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If we didn’t have the buffle grass it would all be like that dune blowout down there. So, you know, that whole strategy has to be relooked at and it has to be based on science and environmental sustainability – which it’s not.

- Like look out here, you know, that alternative energy system there, those panels work in conjunction with the wind turbines and we have battery backup are battery for the wind turbines. We’ve got two complete systems, we’ve got another one down at the other complex. They, and the Artesian water things, you’re talking half a million dollars each. There’s no groundwater here. There’s no creeks or rivers. And they’ve found that, they’ve done a prototype at Quobba up on the Bluff, a few tents at a few hundred dollars a night. People, like I know, I went and stayed at Longitude 131 just looking at Ayers Rock, a thousand bucks a night, you know, I went there for my sixtieth. And when you go and pay that sort of money for a visit, you want a gourmet platter brought to you... that’s the sort of people that go there. And you can’t deliver that here.

- With these tourism nodes that have been created and passed, it sets a bed limit. The potential is there for Gnaraloo and others to not allow camping anymore, to actually do some construction work, build some chalets or whatever and promote it and sell it that way, which then displaces the caravaner, the historical user who’s come up in the tent, the desert dweller who wants to be there for 3 months. When these plans were done they didn’t look at, where are these guys are going to go.

- If it’s now going to cost me $80 a night to be in a chalet compared to $6 a night before, where am I now going to go? And a lot of these plans haven’t allowed for that. They still call it coastal camping, and it may never happen, but there’s always the remote potential that in 10/15 years it may happen. The people that have predominantly gone to 3 Mile are windsurfers and surfers who are happy to sit in their van, camp, tent, whatever. We don’t know at this stage the station owner’s vision or aspiration for 3 Mile. Has he got financial backing to put up chalets and turn it into some classy little resort? They’re the things that we don’t know, and if he does that, where is everyone else going?

- The first place they’ve chosen for this Wilderness Camping idea is Uluru (Bungles Bungles). I guess their models are Karijini and Eco Beach.

- With the government grab for the coastal strip, it was obvious to many of us that there was a long term intent, and it looks like its going to be developing these wilderness resorts in the nodes (with Uluru, Karijin and Ecobeach as their models). We know its going to come – whether it’s this year, next year or in 5 to 10 years time. So the idea of 1000 or 1500 beds along that coastal strip along the reef is getting closer to reality. And the impacts that it is going to have on this community will huge.

- The bottom line is its also controlling visitation that is there already– they’ll make them go to those nodes.

- At the moment, if you want to drive into Ningaloo Station, you drive 2 kilometres down their road, you’re going to go, ‘no, I don’t want to put my car over there’ but if you’ve got a nice bitumen road that’ll take you into a tourist node and you can do a loop all the back round to the highway. So it’s going to add to existing visitation.

- This region is environmentally sensitive, and if they’re going to put all these nodes in, half the locals will be upset, the others will be happy to see them. They should look at how the local community wants to see them driven rather than just the corporate expressions of interest that they did on the eco lodge round the other side. I think that might upset a few people in town.

6.1 Red tape & Red Bluff

- We tried to putting tents at Red Bluff. That was a four year process to get an overall development plan (ODP) in place. When we wanted to put the tents up the top of the cliff, I got told that they were affecting the visual amenities of the Bluff. Now this is a tourist node, it’s been identified as a tourist node with up to 200 hundred people. We’re allowed to develop there, to look after it, put infrastructure in. By having the tents up the top, instead of having to charge everybody double the rate to stay there, we put the tents in at the top and charged them more for the experience. We get fewer people coming through but a higher return, it seems pretty fair. This person in Perth said, ‘You’re going to affect the visual amenities of a tourist node.’ I said, ‘But hang on, you’re standing at the beach, you’re looking at the whales, the birds, the ocean, the waves, you’re not looking behind you.’ ‘Oh yeah, but a boat sailing past out to sea, they’d be able to see them and it will affect the visual amenities.’ Now this is the
person that wrote the draft of the Ningaloo Coastal Strategy. I've got some person telling me that a boat 3 to 4 mile out to sea is going to be upset because they can see a tent on top of a hill.

- I realise it's all politics too, the NSDO were the ones who gave us a hard time at Red Bluff; 4 years and who knows how much money. And yet the ODP for the Blow Holes, which the NSDO did, it took them about 3 months. Ours was a 90 page document, theirs was three A3 pieces of paper. The same crew that gave us a hard time up here, 80/90 kilometres away they did a complete ODP for the Blow Holes, a node of 500 people. They wrote it, they put it on the desk, the ticked it off themselves inside of 3 months. Three A3/foolscap/A3 pieces of paper, that was it. That comes back to politics and red tape. See, it gets down to who you know, not what you know. These are real issues that are going to directly impact on whether people want to come in and invest money on the Coral Coast, on the Gascoyne Coast.

- But it gets down to personal opinion, and suddenly like you say...the goalpost keeps moving, every time you come up with an alternative they shift it somewhere else. That's from my experience with Red Bluff which I thought would take a couple of months to get past Council and then we'd put some stone huts up. We were only allowed to put the tents up so that we could take them down again. And what good is canvas in a cyclone-rated area? And that was personal opinion from David Nunn. We just rocked up and said we don't want to increase visitor numbers at Red Bluff because it'll detract from the experience. People go there to be able to chill out, they've got cliffs all around them and they feel small in a natural world and that's what they want. So instead of trying to get more people in, put in some higher end accommodation.

6.2 Effect on small business

- For example, Red Bluff needed $5 million to get it up to a point whereby you can transfer people from Carnarvon airstrip straight out there, and have restaurants and tours and boats and charters and everything else like that. You are going to need $5 million plus, as far as back-of-the-envelopes calculations are done, to get it set up. Unless you've got land tenure and you're allowed to build stuff, there's no chance. If you do, somebody will be employing 10 to 15 people up there, with families. The flow-on effect is huge – that's if it happens all the way along the coast. But for that to happen, that's probably outside most our expertise. So you've either got to go, not that I'd want to, private or public agreements or you've got to get outside money to come in and run it solely as a single enterprise to do it properly.

- Council's decision to knock-off Maud's Landing was probably one of the most destructive decisions ever made for the Ningaloo Reef. The fact that you had a huge company spending millions of dollars and they still got knocked on the head. Instead of having these planning departments that just stamp ‘no’, if they want investment development up there, maybe they should be saying, ‘If you did it this way…’ instead of just this rubber stamp ‘No, come back with something else’. If they gave some feedback…we just got absolutely nothing. But the planning department is just being mean, it's just the ‘no’ department. It's absolutely full stop. And that's coming from the environmental side of it.

- When you think about the whole coastline, there actually aren't too many big operators. What have you got – maybe the Novotel? And that is the only one that springs to mind that could handle the regulatory overload that's going to come, whereas this whole coastline is run by private enterprise and small business. But you're not going to get anyone like that coming in while the coastline is operating under this planning scheme, like it is now.

- If you put more regulation over the whole coastline here and start hurting small enterprise, then you're going to have less and less people here, then there will be less patrolling of the environmental side of the reef, so you'll end up with more damage.

6.3 Impact on wilderness character

- I get nervous when there is talk about introducing development into greenfield sites, like Gnaraloo Bay which is an iconic location, partly because it is completely pristine and unspoilt without any build structures. You have to think about what that offers and represents not only in WA, but Australia and worldwide. Where can you go where it is peaceful and there aren't people everywhere, jostling for space, jet-skis and boats?
We need to recognize that wilderness experiences offered by locations such as Gnaraloo Bay is part of the tourism product, a wilderness product, that Australia is selling, not just the commercial style tourism which you find in Coral Bay. Wilderness tourism adds to the Australian tourism product, has a commercial value and contributes to economic outcomes. The minute you start carving up the Ningaloo coast for commercial style tourism developments by hoteliers, which is already well represented in and by Coral Bay, the wilderness tourism product will be destroyed and lost. Once destroyed, it’s finished and the opportunity lost for ever. You cannot go back at a future point in time to ‘re-create’ or recapture what was lost because its value is suddenly realized. It will be a case of ‘paradise lost’, like the song says ‘they closed down paradise to build a parking lot’.

One new hotel, then a sealed road, then worker’s accommodation etc – all attracting and introducing further development. Coral Bay was a low key low built location 10 years ago. Now it’s ‘Perth on the reef’ and expanding.

7 Fisheries issues

We’re passionate about doing something about the bag limits for the fishing, it’s not sustainable. I’m talking to the Minister for Fisheries. They’re petrified that there’s 600,000 recreational fishers and they all vote. But the thing that they don’t understand, I believe, is that these days a lot of that 600,000 have changed their ways and they prefer to photograph and release support fish.

We know, because you don’t hear anything here, but you hear everything. We know that there’s people meeting people on the road and we know that there’s people in Adelaide and South Australia selling fish from here that the shamateurs are supplying. We heard that. We absolutely know it. But the Fisheries, because they haven’t got the resources to answer my phone call and come up and look at. This is over the huge bag limits they’ve already got.

There’s so much that has to be done to protect that fishing resource, because I’ve seen it when my kids were this high, you could sit on the beach at Exmouth Gulf, I’d sit there reading a book with my legs in the water, the kids would catch a fish and I’d say ‘that’s it’. Now you can’t do that – there’s so many more people in 45 years. We were there from the beginning and we lived in a tent in 1964. My 92 year old mother’s in there resting because she’s just swept out the shearing shed. She lived in a tent with me and my brothers, you know. Now that’s what I’ve seen in an isolated area with people raping and pillaging, and now it’s drifting down here and further and further afield. It’s a real serious problem if they want to protect the Ningaloo Reef, that’s the first thing they’ve got to do. Make it wilderness fishing, one or two fish a day, that’s it.

The anecdotal evidence for these activities [fishing in spawning grounds, etc.] is there but it’s not getting to us, because of lack of staff to attend to those reports. I want to develop a relationship where we can respond a lot quicker and get more of a result from how we do our business, rather than then just racing to everything we hear. We need to try and get people who report things to gather more intelligence to help us make a realistic decision about going to those particular areas to attend to what they believe is a real issue. If they tell me they see a boat they think is taking too many fish, we say fantastic, can you tell us if they come back in a week, can you give us a boat rego, can you give us the details of the boat; but a lot of the time we don’t get that information. Or we get, “Oh, I don’t want to say much more” because they don’t want to be seen as dobbers. Well, why bother calling? So I want to try and develop that relationship where people look after their own backyard and get enough intelligence for us to act on it.

We had CSIRO camping here, a bloke called Marcelle. He’s been a few times and he’s fabulous, because last time I was out on the south boundary, there was a professionally made octopus trap on the beach and near a camp, and these people just said, ‘oh, the kids just found that’ but I’m pretty sure that they brought with them, the adults, and I was pretty sure they were using it. So I took it, and [redacted] and the other CSIRO guys were coming a couple of weeks later, and he said, yes, because octopus is one of the things that they were focusing, because the numbers are right down. And there is other scuttlebutt, but I haven’t been able to prove or catch anyone, but they’re putting chlorine on the reef to bring the octopus out.

There are concerning incidents where there is a school of fish and with the new fish finding equipment being used by recreational boaters, what they do is they will find a school and don’t just take their take but via the radio let all
the other boats know where the school is, who then take the whole school out. The website Fishwrecked.com has a photo of 35 Gnaraloo reds [red emperors] on a table and the caption reads, ‘What a sensational day, look what we took’. When I attended the Symposium, I learned these are resident fish populations, they don’t just migrate through. So if you wipe out one school, that was the school that was resident in that location. It wasn’t just a passing through school with another school coming through tomorrow.

- Spear fishing: people go out to a large friendly resident fish that is 10 or 20 years old and shoot them dead. And you ask them, “Do you understand what role that animal had in this eco system? Do you understand that the reef is like a lung breathing?”

- So, we have a significant challenge here because we’re already being told that the types or size of fish that you used to be able to take from the Ningaloo shore can now only be found from a dinghy. How long before you have to go out into deeper waters before you find fish?. Fishing should be the enjoyment of most people that come to Ningaloo, it should be possible to catch something if you put your line in from shore.

- [Why do you think they don’t believe there’s an issue?] Because they see the abundance the reef has to offer, they see the abundance that there has always been, and you’ve got people who currently just do not have a generational understanding or focus in regards to use of these natural resources. When landholders / managers confront them about the extent of their recreational fish taking, the issue is that the current bags and the size limits are too permissive, so that they are not doing anything illegal and can easily justify their behaviour. But they take it to the max. We’re saying to them, “But wouldn’t you want your son to have the same experience?” And they reply, ‘Why wouldn’t they have the same experience?’!!

- Fisheries were better than what they are now. One example, I was out fishing in a little tinny, I think they caught a Red Emperor or something and there was another boat 20/30 metres away from them. Obviously the big boat saw them pull up this big fish then came straight over and dropped anchor beside them. Five minutes later, these dead fish started to float past, about 3 big dead fish - they were thrown overboard. They were over their limit, so they threw over the ones they already had so they catch these other ones they wanted. takes the boat number, takes down everything, comes in, rings me. I go, ‘no problem’ and I ring Fisheries. ‘Oh we can’t come out’. ‘What do you mean you can’t come out?’ ‘Oh, we’ve got a fishing competition on at the moment. This was nine o’clock in the morning. I said, ‘What time does the fishing competition finish at?’ ‘Six o’clock.’ I said, ‘It’ll take you an hour and a half to get here, an hour and a half to get home. You’ll be back before they even come in from the competition’. It took four phone calls and emails of photographs of the stuff floating past, before they would come out. I talked to one of the head guys and said, ‘This is a disgrace. These guys have been picked up and told that they’ve been reported, right, and you’re not even going to appear. They’re just going to go ‘ha, we can do what we want’. I pulled them up when they came to the fish cleaning station, I said, ‘Guys, I believe you were throwing fish overboard,’ and they said, ‘Oh no, we were doing catch and release’. I said, ‘I wasn’t there but that’s a load of crap.’ Fisheries appeared and they left the next day.

- I’d say that going back to when I was a kid here, just watching people catch fish and taking fish, the change in attitude to the fishermen has changed so much in the 10 or 15 years, it’s not funny. They’re more environmentally conscious. You’ll still get your half a dozen or dozen groups each year that, if they catch a snapper that big, they’ll keep the thing. But they’re doing rubbish cleanups on the rocks and bringing back bags of rubbish. And they’re even getting to the point where they’re saying, look mate, that’s a bit small, you better put that back. It does become self policing because they know that they’ve got to look after it or it’ll be hammered. The education is obviously getting through. Saying that, I would say the majority are older blokes across the board. So that is a huge change in attitude which for us is good. It’s unfortunate that we’re linked into the Ningaloo Coast because we’re just cliffs and rocks, we don’t have any fringing coral or fringing reefs, it is just thumping great big waves coming up against a rock wall. But we’ve been branded with it so of course when it comes to planning, as soon as you talk about people using the coast, the planning departments go, ‘Oh, well, it’s like the Ningaloo Reef’...

- They just sit on the bombies, and they fish it out, and they’re right within their bag limits, there’s nothing you can do. So that’s another little journey that we’re trying to take and address. They come in their big cruisers and they’re all packed up, and then they just replace every little package of meat with fish. So they go back with the caught fish. We’ve got to have a new possession limit, so they have to eat it fresh.
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- We're facing a significant issue on the reef if we want to change the recreational fishing mentality to a 'low-take/conservation' mentality.

8 Boat ramp issues

- They've put in a boat ramp at Coral Bay, whereas you couldn't launch a boat anywhere before and travel long distances. Now all the big boats are coming up and the technology is such that the fish haven't got a chance.

- All the recent boat ramp at Coral Bay has done is to displace the recreational fishing pressure from Coral Bay to further afield on the reef. At the moment Cardabia and Warroora is under significant increased recreational fishing take. Once those fields are fished out, it will just keep coming down and out along the coast.

- Case in point is the new boat ramp in Coral Bay. What modelling or EIA or consultation was done prior to it? It wasn't there the one day and then it was there the next. There were significant marine pollution issues during construction. It's all just whitewashed because it's a certain politician's pet project.

- The new management plan has been approved and it guides what we do for the day-to-day things inside of the park, that's easy, but it's what goes on outside the boundaries that will impact the park. We're very reactive: the extension of marinas, larger vessels, if Tantabiddi gets developed. At the moment, they can head to Milyering from the new marina in their large vessels, but once Tantabiddi's there, with a larger ramp, what's going to happen? In Coral Bay, there's a new marina facility down there, now there are large vessels, 8 metre vessels, 9 metres and it's a real issue. 16 bins of fish offal a day coming out of there. It's out of control.

- It's not just the recreational user but we also get pressure from commercial operators. We have licence systems, E-class and T-class licences. DPI, who are technically managing that facility, are going 'what is the capacity for this facility to operate functionally?' We've got 13 E-class licences from fishing charters to glass bottom boats, etc etc. Is that the capacity for the facility? Yet we're asking it in a bit of a back to front way. We know the pressures at Coral Bay. I know its supposed to be a free market and a free market sorts itself out, that the free market and competition should decide, but morally, I look at the people down there who've been there from day dot, they've struggled, and they need, I believe, because it's their backyard, not protection but some support there for their businesses. So, DPI, please tell us the facility has a limited capacity for commercial operators, so when we get people saying, 'look I want to operate out of Coral Bay,' we can say 'sorry, there's no space, until DPI build a brand new facility, it's reached its capacity.' Then we've kept the local community happy and business is thriving, they can employ people, maybe they can afford the houses now.

- There are only x amount of E-class licenses; if you've got an E-class, really what your licence gets you is a mooring, you can physically leave your boat there. A T-class licence is a class under DEC that allows you to operate but you have to remove your vessel from the water. So we're getting a lot of requests now from T-class operators saying, hey, new facility, I want to access Coral Bay. In the past we didn't allow that, we didn't allow access into Bill's Bay due to the fact that there was no marina or boat launching facility. It's all changed. Pressure after pressure due to progress. With a new boat ramp, a couple of hundred T-class licence holders legitimately could come in and set up business in town. What's that going to do to the established businesses in town, who, yeah, were making ok money sometimes struggling? Ultimately the wealthiest will survive. If I'm a T-class operator, and I can now do this, this and this, and I've got financial backing... Little Joe Bloggs down here, family business, he's now gone. Now is that for me to worry about? Possibly not. But I struggle with that at times.

- Look at what's happened at Coral Bay with the new boat ramp. You put an improvement in then there's a direct correlation to something else down the road. Whether that was considered at the time, I don't know. Maybe they decided fish in the 10k radius around the boat ramp are going to be decimated, but we won't put one in Tantabiddi, and we won't put one somewhere else, therefore that'll restrict and control it to that area.

- That whole thing with that boat ramp in Coral Bay got so caught up in a load of political crap, and they did not listen to the concerns the community was raising about all the things that were going to happen which are now happening. The sitting of the coral has started, the big boats that are all coming so the fish populations are going to get nailed.
Minister [redacted] the Planning and Infrastructure Minister at the time, wanted the boat ramp in. The most appropriate place for it would be Point Maude. The community wanted it at Point Maud to get it out of the bay and away from the coral and to not have as big a thing as they’ve got. But because of the whole Maude’s Landing resort thing, they couldn’t afford to have any publicity that said that they were going to build anything in the Maud’s area. And the developers of the Maude’s Landing resort would have sued them, if government had of put something in there. So political stuff won over environmental issues.

9 Industrial issues

9.1 Industrial development

The opportunity to make a decision about this being an ecotourism place has been taken away already by the State Government with all the oil and gas stuff that’s going on, and that’s a shame. Nobody thought about it. When the first rig went out there at Enfield, how many years ago, a lot of people thought, ‘wow, this would be really good for the community, money wise.’ And all of a sudden we’ve got Woodside contributing to whale shark projects and people were able to access money for oil and gas money for lots of conservation and community things, so they dangled that carrot... the acceptance comes in.

Now we’ve gone from one bloody platform to a horizon of platforms and all those ships all the way around. I remember [name redacted], who is the chairman of Australia’s Coral Coast, sitting at one meeting about this years ago, saying ‘so do we say ‘excuse me, all the visitors here for tourism please look to the left and those interested in heavy industry, look to the right’?’ and that’s exactly what we’ve got happening here now.

It’s not going to change now, because there’s too much money being put in there now by those companies. The government gave the green light on it all and it’s getting bigger every week, more and more offshore boats coming in and out of that marina for servicing those rigs. They need to build that second marina already, and they’re going to build it because the demand is there. At this point, the government can’t tell the mining companies, ‘oh no, sorry, we’re not going to build another marina to support the industry that you’ve got billions of dollars invested in’.

Mining has got its foot firmly placed here now already. There’s no consultation about anything anymore. There used to be when it was all starting out. Woodside used to have these public meetings all the time and ‘this is what we’re up to’ and all that. But now you’ve got Chevron out there, you’ve got Woodside.

The young are the ones doing the offshore work and earning $400 a day to be a deckie on a boat going out to the rigs, they’re thinking, ‘life’s fine.’ The prawn fisherman, the builders and tradies building all the resorts, it’s all paying for their lifestyle to be here to go fishing and surfing.

I was up at the lighthouse watching the sunset a couple of years ago, and I hadn’t been up there when the sun had gone down for ages. I looked out at the horizon and then I could see all those lights and it’s like ‘Oh my God, what had happened?’ I hadn’t realised how much had gone on. They’ve all popped up, crept up one by one, when did this happen? Even now I go down to the Gulf everyday and look out and there are all those boats.

Friends of ours have got a boating business up here that services the oil and gas operations - crew changes, stores and stuff for the boats. One by one all the guys that were all working in tourism are all switching over to go on those boats. Well, you could go out and earn $170 a day doing a whale shark tour, if that, or go earn $400 a day. What are you going to do? There’s a few that say ‘no, this is where my heart and my soul is’ but there are others going, ‘geez, I’ve got a wife and a kid and I need to pay a mortgage and I can’t afford to pay the rent and I want to buy a house and live here’. It’s a vicious cycle.

I’ve been on the stakeholder reference groups for BHP Billiton and Woodside from the inception and they started doing some modelling for oil spill modelling out on the rigs. They did a model for one month in October and I just laughed. I said, ‘Guys, you’ve got another eleven months in the year where winds are different and you’re telling me in October there’s no chance of oil coming on to the coast.’ And I said, ‘I’ll be happy when you tell me that’s the case for all the months.’ So they then had to go back and do another eleven months of modelling and then they
came out and said, ‘Well, there is a possibility in June and July with the prevailing winds...’ But and I were both on the committees and quite often they’d come up with stuff and I’d go, ‘Yes, but...’ ‘Oh, they were doing with LD50’s on different organisms and they said, ‘Oh, we’ve come up with this is not a problem’ and I said to them, ‘Well, what about mangroves?’ Mangroves are very susceptible to oil and petrochemicals and I said they found with white mangrove which is the predominant mangrove around here, it actually produces albino propagules which then don’t grow properly. So I said, ‘Have you done any trials on mangroves’ and they said, ‘No.’ And I said, ‘I know this guy that I went to uni with and he’s now one of the top mangrove ecologists who specialised in looking at the effect of oils on mangroves, so I said you better contact him. So I contacted him and he said, ‘Oh yeah, we’ve got a whole set up to grow them in these situations with the particular oil they’re dealing with.’ It’s just a case sometimes having community members on these committees who have got no science background, but if you’ve got that science background you do just then have enough knowledge to ask the right questions. Because a lot of people wouldn’t have a clue what the LD50 was. So then people sit there and look at you, like, ‘God, fancy asking that question’ but it also keeps the people on their toes because then they go, ‘Hang on a minute, I can’t pull the wool over [redacted] or [redacted] eyes’ and even when they were talking about dispersants and [redacted] and I were having a conversation with them saying, yes, it’s dispersed but then it drops through the column and can get washed in on da-da-da-da and they’re going, ‘here they go again’.

9.2 Access to industry research

- I think a lot of the research that’s done by industry is not available. You can’t get it. And I guess they can then do whatever they like with that research. Some of the reports are available for the public to look at. But I know that we’ve tried to get hold of stuff from oil and gas and it’s not available. I guess they own that research. And I guess the concern is that its not transparent, because they’re putting that research into their management plan or their environmental impact assessment, and how do we know how much truth is in it? It’s pretty easy to twist words. We had a classic case with Straits where they’d sat and told the shire how this project wasn’t going to affect fisheries and prawn stocks and all this kind of stuff, and they didn’t realise that a co-author of the paper was actually sitting in the room, and the co-author said, ‘What you’ve just said about that not affecting it is wrong.’ And they said, ‘No, no, look it’s all here’ and they read out all these quotes and he sat there and he said, ‘I co-authored that paper and that is not what that paper says.’ So they were basically caught out absolutely lying in a public forum to shire councillors, when both sides gave a briefing about the salt mine, and the researcher is sitting right there! And there was another case as well, and that researcher actually contacted the shire and said, ‘I believe that Straits have said this and this and this about my papers, I can absolutely assure you that in no way, should this project go ahead, I do not support it and what they have stated about my research is completely incorrect.’

- So that’s how industry can twist what goes on with their research, and you could probably get a hold of those papers. But who’s got time to go through all those papers and then do a critical evaluation of every one? Consultants get paid thousands and thousands of dollars and put in thousands and thousands of hours to do it. A community group can’t. Government probably can’t do it unless they’ve actually got someone you know focused on a project to do it. So really there’s a lot of power in industry because some of this research isn’t transparent and not available. But then again, yeah, it’s sort of going around in circles isn’t it, because even if it was, who’s got the time and the resources to read it and assess it and to evaluate it. And what community has the people with the knowledge and scientific background to be able to do that? It would be incredibly useful, to have someone like an independent sort of broker in the community.

- One person who’s been really helpful to us is a woman called [redacted]. She’s the community liaison officer funded by Woodside and BHP to prepare responses to all their environmental plans etc etc etc, on behalf of the stakeholders and the community. When BHP or Woodside put out an environmental plan or an oil spill contingency plan or something, she puts together this absolutely amazing submission with all the quotes about the legislation. She’s probably a little bit over the top because she’ll highlight the teeniest most menial issues, but it’s so comprehensive and so thorough and her knowledge is absolutely amazing because that’s all she does. We then have input and add our local knowledge then we submit that application. So BHP and Woodside have actually provided the community with this fantastic knowledgeable resource funded by them to assist our evaluation and feedback on their environmental strategies and plans. She fills something like a broker role, and she’s funded by industry. She’s so professional that everything she says, there’s the supporting evidence. She
knows so much about the legislation and the processes as well which, for a community group is pretty hard to wrap your head around particularly if you don’t have the background in that area.

10 Marina expansion issues

- They ran a community workshop up here to get people’s ideas about the marina expansion. I must say the community consultation by DPI on that was absolutely fantastic. It was really good! However, having said that, a lot of the questions were loaded, and we didn’t have any parameters for this proposal, no parameters at all. So it was very difficult for people to comment on something with absolutely no framework in place and that was one of the big problems with it. But statistical analysis in their report was so dodgy. They loaded it so they might say “80% of the Exmouth community support the expansion of the marina to this capacity”, but when you actually go back and look at the numbers, it was like 12 people. So they had done that sort of stuff in the report to get it over the line.

- Now from our point of view, we put a lot of time into the original submission on the marina expansion and I don’t think any of it was even considered. And then when I scanned the report, I just went, ‘This is crap, this is just such rubbish!’ But you just don’t have time to read it, respond to them and say, ‘Hey look, we’re really concerned about the way that you’ve crunched this data,’ when you’ve got all of these other priority jobs, trees being felled and turtles being disturbed. As a community group, you just don’t have the resources to do it. And that’s one of the biggest problems and can I honestly say that Cape Conservation Group has been probably the biggest environmental watchdog up here, but we are so under-resourced and there’s so much happening, and there’s so much getting through that shouldn’t be going through…I don’t know, I think the situation’s quite desperate.

11 Groundwater issues

- The Chamber a few years ago made a concerted effort to engage the Water Authority about the reducing of the aquifer. Without essential rainfall, those aquifers are not being replenished. Unless alternative sources are found, the town’s ability to grow and sustain is limited.

- If you’ve got a finite water source that depletes because of low rainfall events over a three year period, then (which we have recently) the aquifer is depleted to such an extent that the bore fields are unable to make up the loss of water

12 World Heritage issues

- They interviewed me about World Heritage on the radio here the other day when it was announced, and I was mixed...I just said look I don’t know, obviously there’s good and bad things. Being a commercial operator it’s probably not that flash for me. Private citizen, yeah, go for it. But as a commercial operator, no I don’t think so. The only person that’s making money out of this is going to be DEC. Another World Heritage, it just restricts development.

- It’s a good marketing ploy. Like, if we want to develop new products, like set up a resort on and island out there, oh no, World Heritage, forget it.

- [You have to actively market it as World Heritage otherwise it doesn’t really have an impact on visitor numbers]. No, but it has an impact on services, infrastructure and development that are able to be provided, which is huge. If you can’t get that infrastructure in place, then even if you market it, you don’t have anything the visitors can do.

- Shark Bay has had World Heritage over it for 20 years and they’ve got a tin shed out the side of the airstrip. Now, I’m not sure if that is purely because the red tape and bureaucracy has stifled development, if they weren’t allowed to build on any airstrip or a terminal because of World Heritage. That stifles people coming in, it doesn’t give
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anyone anything to do or places to stay, where. Now I know for a fact that it took the Shire down there 3 or 4 years to get permission to use a gravel pit to fix a road, because they were going to shift a couple of hundred bushes. The red tape that goes along with World Heritage listing is going to absolutely crucify private enterprise, and it will crucify any government enterprise too, because they're not going to be able to put up anything else. I think that is the most probably a very large threat to tourism here on the Coral Coast.

- I know when the World Heritage information came up, some people got together and flew up some people from Shark Bay and they had the 3 people from the World Heritage Consultative Committee here as well, and they had a big public meeting and there was probably 200 people – which is a lot from a township this size, and that was really well attended. Then DEC brought up a two day road-show with information about World Heritage and they probably had 12 people over the 2 days. A lot of people are against World Heritage. I think the issue comes with the control. They generally would like to protect the environment, but it's the control and who's controlling that protection.

- If World Heritage gets up there nothing anyone can do about it. We should look at Shark Bay to see how the pastoralists over there have dealt with World Heritage.

13 National Landscapes

- But everyone says, you know the National Landscapes, the branding group for Tourism Australia and Parks Australia? I'm digressing a little bit but you'd know yourself how many national parks there are in Canada. There's 47. How many national parks are there in America? 51. How many national parks are there in Australia? 639. Do we value our 639 national parks and are they special national parks? There are a lot of national parks. If you're driving around America, you know if your going into a national park, it's well worth going to. They value their brand. We've devalued ours. So Tourism Australia and Parks Australia have done that research and I think it's great. Then they look at me and go, well, how do we redo it, we can't get rid of national parks, so now they're looking at National Landscapes like, say, the Kimberley, the Great Barrier Reef, Great Ocean Drive, but they're going to keep it to 15 to 20.

- Of course if there's Ningaloo, we'll also have Shark Bay because their value is the same, there's only going to be 2 National Landscapes in Western Australia, because they'll only have 15 nationally. I've got to try and justify how we can be one of the 15 compared to Flinders or something like that. If the community's not driving it because they don't understand...at the moment it's all too hard for me because the information isn't user friendly or education friendly. If you had a Research Centre that had all the information... if all the information's there it would help.

14 Local attitudes

14.1 Business

- [Do people want an improvement?] No, that's the problem, they don't, and they've been handed their business by their parents, and they don't want any changes. We've got a comfortable life now – why do we want to change, what's going on here? I mean everything's nice and cruisey at the moment. Why would we want an extra 10,000 tourists coming in? Oh, no, no, no. I think they're quite happy with where they're at.[Do you see that as a problem?] Oh, yeah, that's Exmouth's biggest problem.

- I only started this business 7 years ago and now we're the biggest dive operator outside of Queensland. I mean, and it hasn't been hard, we don't do anything special, we just educated people, you know, and provide a bit of service, raise the bar a bit, hence why we've done well.

- Until more new businesses come in and then suddenly these people are being forced out and they're the first ones to jump up and down, going what the hell's going on. That's when the problem starts and that's when boats start to
get sunk and so on and so forth. Several, boats have been cut off moorings. It happened to one of the longer standing operators here, the boat was cut off its mooring and found out 3 miles off the reef. Oh yeah, that happens quite a bit, tyres constantly getting let down in car parks of buses and things like that, oh yeah. That’s why I say you’ve come to a real redneck town here.

• The thing is, there’s no marketing strategy for the town either. We’ve been asking these questions recently as the committee at the Visitors Centre. Ok, well where’s the direction? Where are we going with this town? What are we aiming for? Who’s got the plans? Who’s got the big picture? Nobody’s got any.

• There’s a few people that want to change the town. There's a lot of people that want to keep it the same.

14.2 Chamber of Commerce

• The Chamber’s proactive initiatives have been actuated by a few for the benefit of a number. Within the Chamber is the acceptance that there are a few that can perhaps make better approaches to companies and government departments to act in the best interest of the community.

14.3 Towards the environment/fishing

• And certainly, locals that have lived here all their life –twenty years ago they would have just kept fishing until they ran out of fish, but now they wouldn’t go over the bag limit. Very different attitudes. I think its just education. They could still get more than their bag limit, so fewer fish isn’t what’s stopping them getting more than their bag limit. People talk about the amount of fish they used to get and it certainly seems to be less fish. But there was probably less people fishing, and they didn’t have depth sounders and fish finders, big boats with motors.

• One of my mates father was a fisherman when they grew up 40 years ago. He had a little camp and for his occupation, he used to just get fish, big freezers full of fish. It’s different now. was telling me about the turtle boats that used to come up and take turtles, hundreds and hundreds of them. it was just something that happened and, at the time, that was what you accepted. And there was the whaling station and that was still very acceptable in society to go out and catch whales and pull them in.

• I think probably the majority of the local stakeholders do want to see Ningaloo preserved but they want it preserved because of their personal lifestyle. So that’s why they’re not necessarily supportive of World Heritage because they see that as having a negative impact on their lifestyle. I don’t think a lot of local people want the place wrecked.

• We saw it with ‘Save Ningaloo’, probably the biggest environmental campaign in WA. People feel really precious about Ningaloo. They might only come here once in their life, but they really, really feel precious about it.

14.4 Towards oil and gas

• They can see the $6 billion dollars sitting out there – they can watch that, and they see the people that fly into the airport and then they fly away, and they’re like, well, hello! Where’s my bit? I have to put up with the helicopters going over all the time. All they get out of it is some drunk men on the plane. Yeah, there is a bit of resentment there, I think. Mind you, they do throw a lot of money at the community – not in their terms, a couple of cents, you know, but in community terms when they give the playgroup $10,000, small amounts can make a big difference

14.5 Local vs national/international

• This is probably going to sound wrong, but although what the community here wants is important, I think that this area is not just about this community. What the community wants is X, Y and Z, but look at how special the area is – this area is important to the West Australian, the national, the international community. So how much weight do you put on what the local community want relative to what’s important in the national or global picture even? At least the West Australian picture. I think the real saviour for this area is not going to rest locally, it’s going to be from the broader community in WA.
14.6 Political leaning

- I know this town has had a lot of people convert to the National Party. When this local Member of Parliament swapped from Labour to National recently, he took a lot of people with him. And that Royalties for Regions has certainly won a lot of votes. People can see money coming.

15 Renewable Energy

- It’s the perfect spot for renewable energy. We’ve got a 2.1 kilowatt system at the school but that only happened because I got it happening, because we had an upgrade to the school and when they do anything like that now, it’s all got to be public consultation so teachers, students and their parents could be involved. But we had a meeting, it’s called the Local Area Education Planning Committee, which was basically run by a guy from the district office in Karratha, and they came down and they showed plans of what was going to. It was compulsory for all the teachers to attend this meeting, there were some other people from the Shire, the whole room was full. And then they said ‘Are there any questions?’ And I said, ‘Well, yes, what are you doing to address renewable energy? I haven’t seen anything that shows you’re going to have any renewable energy.’ And they looked at me and looked really embarrassed. And I said, well, you know, you’re actually building a new building. Wouldn’t the most logical thing to do is put some renewable, to put in a photovoltaic system? And because I’ve done my research, and I said, the Department of Education and Training is part of the Energy Smart government initiative, so you need to comply to reducing your energy budgets by 12% by 2006/2007 and they went, ooh, shut her up. So they said ‘well, there’s no funding for it and there’s no plans for it’ and I said, ‘Well if I may say so, that’s really short-sighted. This is the highest solar resourced belt in Australia that we’re part of.’ And so their answer was, ‘Well, if you’re so passionate about it, you find the funding and you do it.’ So I did. I got $85,000 out of BHP Billiton for the school and out of that I bought scientific equipment I would never have been able to do, put in a 2.1 kilowatt PV system and I’ve now got another $50,000 from the Federal Government to put in another 2.0 kilowatt system and $30,000 for rainwater tanks. But it shouldn’t be up to the individual. I spoke to Ministers who came up here and I said, ‘Look, if I hadn’t driven this, it wouldn’t have happened.’ And I said, ‘It should be mandated guidelines – you’re building a new building, you need to address renewable energy.’ And it doesn’t happen and it’s just so short-sighted, it’s not funny. If it was mandated guidelines then it would be easy. It would just be ‘this is what we’ve got to do’.

- But then you get something like the Department, they used to be called Housing and Transport, they’re now called Maintenance and Management or something like that, and we wanted to put up a shed in the Environment Centre and I got quotes from one of the local businesses. And then I went to see the Principal and he spoke the regional guy and he said, ‘No, no, if you want to set up a shed, we have to build it for you’ and then they added 15% on top, and it’s the same with the solar – if I could just go out there to the guy in town who does solar, it would be a lot cheaper. But now they’re giving the contract to someone in Geraldton who then subcontracts to the guy here. So everybody wants to take their little bit. I probably won’t get a 2 kilowatt system by the time everybody takes their little bit, and I don’t get a choice in going out to tender. The Departments, the Federal money is then being dished out by the States which is fair enough, but it’s all...if I hadn’t read the fine print on the website, you know, I was ready to go out and... ‘Oh no, you have to contact DET’ so I contacted DET and they said, ‘Oh no, you can’t...your school’s not down to get it until 2010/2011.’ And I said, ‘But I put in and I was granted this last year’ and she said, ‘Oh no, hang on, you can do it March next year but you can’t just go ahead and do it, because we’re...we have to get contractors’. I mean, ok, it makes it easier for me because I don’t have to go through all that tender process which I did when we got the 2.1 kilowatt system.

- And my role is to teach but I do all this other stuff. I mean, I brought a team up from Perth to get the environment centre one step ahead so they came up and did a great job. But I got a grant from GDC Royalties for Regions, so now we’ve got veggie gardens and fruit trees which is just that one step ahead. It’s all about getting these kids aware that you can do this at home or this is how you do composting, you know, it’s simple stuff but not all parents do it. So maybe the kids do get enthusiastic enough that next year they go, hey, I want a veggie garden at home. We don’t use any fertilisers, we compost, it’s all organic, naturally grown and it’s also water wise as well. So they
know all of that process, and simple steps but that's what we do. And the pump that we're getting for the pond down there is a solar pump.

- Obviously the older I get the more I know that it's slow, slow, slow and you take a few steps forward and then there's the odd step back, and you keep on going, and gradually you get a child who goes, 'See that house that's being built?' 'Yes.' 'Well, I'm really angry about that house.' 'Why?' 'Well, look, it's got a dark roof and it's got dark walls. How stupid is that because they're going to have to use the air conditioner so much.' And I go...and this is not one of my really, really bright students, this is your archetypical blonde and suddenly she's switched on. And then I said to her, 'Well, now you know what the right thing to do is when you buy a house or build a house. You've got to make it solar passive.'

16 Ningaloo Turtle Program

- One of the reasons why we started the Ningaloo Turtle Program was because there was a young guy up here doing his PhD, and he brought all the volunteers that he used up here from the university, which is fine, but he actually rang me two years prior to coming up here and said, 'Look, your name's been given to me by some so-and-so because you're in the Cape Conservation Group and you're also at the school, and I would like to try and involve the community in some way.' And I said, 'Oh, that would be great.' And then he never contacted me again. The first year he came up here, we actually contacted him and he came and gave a talk to the kids, because we had kids camping over the other side, and so I said, 'Can you come and talk to the kids?' And when he arrived, he said, 'Oh, you're and I said, 'Yes.' And he said, 'Oh, I must come and talk to you about getting the community involved' and nothing happened. Then I invited him and his volunteers here for Christmas that year, just because they were stuck out at the bothy. This guy said, 'I'll come and contact you about getting you out there to see what we do.' And he never did. Not that I felt miffed but he kept saying he wanted community involvement but he was a bit sort of just paying lip service to it. So then I bumped into this guy again at the airport and I said, 'Well, look I'm going for twelve days,' and he said, 'I'll catch you when you get back.' And then when I came back he'd left town a month earlier than he was supposed to, and then he rang me from Perth saying, 'Oh, can you and DEC continue to do the monitoring for us?' And I said, 'I can't do the monitoring if I don't know what your methods are. You didn't bother to contact me to take me out there.' And the then district manager was furious because she said that wasn't part of the DEC staff's job to do this. So there were some issues, the way the guy handled the whole thing was not good.

- And I spoke to , I said, well, why don't we do something? So got some turtle packs, just some leaflets that DEC had, and we took people out and we just kind of wandered along and we just started showing them different turtle tracks, and then we decided (and this was at the end of the season) and we had quite a bit of interest from Cape Conservation Group. So we decided that we would put in for a grant to try and set it up for the next season. This was only a pilot project. And so we got who works for DEC as the threatened species coordinator for WA, and she was just great. She helped us get the grant and so we got our first ever marine based grant from WWF, a TSM grant which allowed us to appoint a coordinator part-time for the first turtle season ever. As the coordinator she did the timetable for the volunteers, we started training volunteers: the guy who was doing his PhD then came up and started helping us. After the first year we were basing it on the data that he wanted to collect. But then I sat down with and said we don't need to know how many pits the turtle has dug, etc...we're not interested in that. interested in it from a human interaction perspective, we're not, and it's taking a lot of time. We don't need to do the last pit that the turtle's done and find that she's done 13 pits and not nested. All we need to know is whether they've nested or not nested and whereabouts on the shore she's nested, that sort of thing. We just need to know the different types of turtles coming up. So we then changed our datasheet to suit what we wanted rather than what he wanted.

- We won awards, we won the Coastal Community Monitoring Project for Coastcare, and we also won the State Landcare Award a few years ago. Cape Conservation Group also won the Len Howard Award through CCWA, and we're still going strong. We then got a big grant from the NHT through the rangelands group to do a cross-regional project. We've got a website and we're very open with all our stuff, our reports go on the website.
• This is why we get a volunteer coordinator for the turtle program. This year, we’re only doing it for 3 months because they’ve cut the program down so much that we’re actually only doing daily monitoring for the whole month. Before that we’re going to do certain weekends in November, and certain weekends in February, and so the program’s changed from where we used to do 3 months solid every day. And this year we only need 12 volunteers so we’re actually going to get paying volunteers this year, because we must be the only program that’s never asked people to pay. I mean, ok, they come up and they pay their accommodation but we always et subsidised accommodation for them and they pay for their own food and all that, but that’s no different from if they were living in Perth. But if you go and do the loggerheads at Shark Bay, you pay. If you do Earth Watch, you pay. If you CVA, you pay. There was a guy from Sydney, he does sort of like specialty tours for people, and he was interested, he came over and actually did some training with us. So this year, we’re only doing it for a month, and the people coming in for that month will pay, and it’s quite cheap compared with others because it’s only $900 for the month, whereas you do two weeks with Earth Watch and it’ll cost you $4,000. So it’s still cheap but what we realise now is that we’ll probably lose a lot of the university students who just won’t be able to afford to do that. Although the $900 covers their accommodation, that they’ll be sleeping in swags at the bothy so whereas before we used to have them in town. We couldn’t do it without having someone dedicated for that time to actually coordinate it.
7. MODELLERS CAN HELP THEIR RESEARCH MAKE A DIFFERENCE

7.1 Summary

This chapter looks at how modelling researchers can serve as change agents. In particular, it looks at how they can facilitate emerging and adaptive behaviours in organisational systems, such that research and modelling has higher uptake for decision-making. First, this chapter looks at the challenges faced by modelling researchers in the Ningaloo system, and how these challenges necessitated a flexible, emergent approach to a participatory modelling process. Second, it looks at the emergence of adaptive behaviours among researchers and within the research program, and among groups and organisations in the Ningaloo region. Finally, it examines the factors that inhibited the emergence of these new behaviours.

Key findings related to this discussion are:

- While acknowledging the complexity and adaptive nature of the system being modelled, the methods for undertaking modelling projects are often conceived as if they were occurring in a relatively controlled environment. For instance, the researchers assume that the same group of people will be involved throughout the course of a modelling project, that priorities remain constant, and that the people who are involved will influence policy decisions. These are not realistic expectations in a turbulent system which is characterised by constant change, high staff turnover, and low connectivity between groups.

- Because tourism and other extractive industries are part of complex social-ecological systems, they tend to be turbulent (dynamic and unpredictable) and suffer from ‘wicked’ problems, and therefore resist planned or controlled changes.

- Researchers can create introduce new perspectives (diversity) and increase connectivity among the people (agents) in the system under study by iteratively conversing with a range of stakeholders in the process of developing models and promoting model uptake. In the Ningaloo case, as researchers and research administrators intensified their interaction with stakeholders, they became more responsive to stakeholder needs and concerns (i.e. they became more adaptive).

- This behaviour on the part of researchers then triggered emergent behaviours among some groups and organisations in the Ningaloo region. Local individuals and groups began to have more interest in using the modelling research for decision-making, and began to self-organise in ways that facilitated the transfer of modelling knowledge and capacity.

- As these new patterns of behaviour emerged, they were countered to a degree by a number of inhibiting factors, including anxiety among some researchers, slow response times to emerging local behaviours, no regional representatives on the research management committees, and the transient nature of research programs, connected to research funding cycles.
The implications for management are:

- An adaptive modelling project, where modellers act as change agents and projects are structured to take advantage of new emerging behaviours, requires the capacity to act quickly to encourage these behaviours, and roles for locals in research management. It also requires modellers who are well and regularly connected to enough organisations with enough diversity to begin a process of change, and who have the capacity to identify and take advantage of information systems within stakeholder groups. Modellers also need to respond quickly and effectively to factors that may inhibit emergence, and therefore model uptake.

- Emergent stakeholder engagement approaches may prove to be realistic and practical in turbulent situations where structured engagement and research uptake is frustrated by the dispersed, polarized and/or fluid nature of the stakeholder groups and the ‘wicked’ nature of the problems involved.

- In summary, when working in changing and uncertain (i.e. turbulent) socio-political environments (such as those characterised by high agency turnover and/or poor and volatile connections between people and organisations), researchers and managers need to intensify and expand stakeholder engagement, be flexible in their approaches, and be open and responsive to new ideas and behaviours that could potentially improve research and modelling uptake. This process can be assisted by deploying a knowledge broker in the study area for an extended period.

### 7.2 Introduction

When modelling projects are ineffective, it is generally because they have failed to sufficiently engage with affected groups. Dray *et al.* (2006) note that the early stages of participatory modelling approaches are often overlooked, where the worldviews of stakeholders and their relationships are assessed. Dray *et al.*’s criticism indicates an assumption of modelling—that a model will be culturally acceptable. In some Role Playing Game modelling, this assumption is reasonably realistic due to the efforts of researchers to understand the cultural assumptions of stakeholders (Dray *et al.*, 2006), or their care in not prescribing solutions to problems through model design (D’Aquino *et al.*, 2003). However, this is generally not the norm in modelling processes. Although a standard modelling approach would now include participatory processes, there is still a set of unstated assumptions about the implementation process, particularly that the model (or more broadly, a modelling solution) is culturally appropriate for the stakeholder group that it is trying to assist.

A guide for modelling processes with a focus on stakeholder engagement and participation is Marjan van den Belt’s *Mediated Modeling* (2004). She divides the process into three stages: preparation, workshops (including qualitative and quantitative model building), and follow-up. The preparation phase is extensive, including identifying and assessing stakeholders (including champions and social networks) who will be involved in the process from start to finish, conducting a series of introductory interviews, and preparing a preliminary model as a point of reference for participants to work from, or reject completely. In the workshop phase the modelling team works extensively with the stakeholder group to develop and test the model, including specifying indicators and variables and testing the model. The van den Belt approach requires a high level of participation. This kind of process assumes that the same group of
people is involved from start to finish, that the level of engagement remains high throughout the process, and that once completed, that the involved group has the capacity to either champion cultural change following their own transformed understanding, or that behavioural change will be enforced.

Model uptake is more likely in situations that fit this set of assumptions, but these, unfortunately, are relatively rare in reality. Even in fisheries, where models are widely used, an adaptive process has been required as well as years of repeated stakeholder interactions. In Australia, for example, the willingness of fisheries stakeholders to accept model proposals and findings is due to much hard work by all parties (industry, management and modellers) and a culture of involving fishers, industry, managers and researchers in Management Advisory Committees. Although fisheries has a more clearly defined group of stakeholders than does tourism, it suffers from the same list of issues we discuss in more detail below – attitudinal inertia, high turnover rates (particularly in the regulatory bodies), communication barriers and a mismatch between the scales of industry operation and the speed with which management bodies can respond. The multi-stakeholder research assessment groups that are a feature of Australian commonwealth fisheries management of today (Smith et al., 2001) are one example of how science delivery to resource management in Australia has evolved. It now has the capacity to communicate with the rest of the industry and to highlight the need for, and assist with, behavioural change when required by changing regulations. The presence of researchers in management processes also assists the long-term engagement of all parties in management. This structure (and all the effort that has gone to see the management system evolve to this point) has paved the way for ecosystems modelling to inform the management process and to assist a shift in the fisheries paradigm from single species to ecosystems (something the fishers welcome as it more intuitively matches their understanding of the system). In other fields, such as tourism, the decades of preparatory work have yet to occur, so management and communication hurdles must be faced in full force. Moreover, given the array of pressures facing socio-ecological systems today sectors such as tourism must quickly learn the lessons of fisheries while trying to avoid the crises fisheries have suffered during the evolution of their management systems.

Using projects within the Ningaloo Collaboration Cluster group of projects as a case study, this essay explores our experiences as researchers running a modelling program with a strong emphasis on engagement. We focus on the adjustments we made to our projects and approaches in response to changes in the region and dialogue with local and regional stakeholders. In particular, we examine how modellers can behave adaptively within complex, human systems that are themselves difficult to predict or control. We argue that adopting approaches that treat organisations as complex systems are conducive to model uptake. We also believe that potentially, these approaches can lead to broader systemic changes that move communities towards more sustainable resource use. In addition, we argue that these approaches are particularly useful when dealing with ‘turbulent’ organisational systems (uncertain and disordered) and so-called ‘wicked problems’ (Rittel & Webber, 1973). Wicked problems are complex socio-environmental problems that span multiple disciplines and world views. They are impossible or difficult to solve because they can’t be singularly defined, they don’t have right or wrong solutions (just better or worse as subjectively defined by involved stakeholders), they have numerous subjective causes, and their implemented ‘solutions’ have significant consequences, meaning there is no opportunity and trial and error learning (Rittel & Webber, 1973). The ideas explored here are preliminary and form part of Ms Kelly Chapman's doctorate on A complexity-based approach to knowledge brokering and research uptake: Working to
build adaptive institutions in Western Australia’s Ningaloo Region at Edith Cowan University. We anticipate that this chapter will be revised into an article once Kelly has further developed these ideas in the context of her doctoral research.

It is worth noting that some modellers are cognisant of the impossibility of capturing the complexity of culturally determined interactions and decisions, and have grappled with how to undertake modelling that can cope with diverse stakeholder groups. For example, in addition to incorporating a diversity of stakeholder views in their models, D’Aquino et al. (2003) also involved stakeholders in designing and using their models. This intensive engagement creates the iterative dialogue and interaction needed among stakeholders to explore options and improve their collective decision-making capacity, i.e. it creates the necessary conditions for emergence of new behaviours. D’Aquino et al. (2003) argue that such ‘self-designed’ and empowering modelling processes are more likely to lead to better governance of resources than expert-built models generating specific resolutions for complex problems, resolutions which may or may not be taken up by decision-makers. From this perspective, the models are culturally appropriate for the stakeholder groups because the game is broad and flexible enough to encompass culturally influenced interactions and priorities. This breadth allows the process of developing and using the model to generate empowerment and interactions between agents in the system, from which better decision-making behaviours emerge. Although this paper deals with the interactions around model development and use, it also addresses the broader issues and opportunities around research uptake.

7.2.1 Tourism, Research and Modelling in Ningaloo

As reviewed in the first two chapters, due to the attractiveness of the Ningaloo coast’s natural attributes, tourists are a major economic driver in the region. Tourism development to date, however, has been somewhat ‘ad hoc’ (Wood, 2003) and the region is challenged with balancing tourism development and management of ecological resources. Additional challenges include: conflicts between pastoralists, residents, tourists, and protected area managers over land tenure and management priorities; housing issues in Exmouth and Coral Bay; and concerns over fishing restrictions and changes to residents’ ‘way of life’.

These concerns are being addressed by research projects in the Ningaloo Collaboration Cluster (NCC). They cross a range of disciplines with the goal of describing, understanding and modelling the processes of human interaction with Ningaloo Reef in support of sustainable management of the region. Two projects within the NCC are developing computer models to explore management scenarios that can help sustain the ecological integrity of the region (Hall, 2000): the Ningaloo Destination Modelling project (NDM) and the In Vitro Ningaloo model developed by the CSIRO’s Marine and Atmospheric Research Division. These two projects worked together in the region to promote the models and to establish a platform for ongoing model use. It can be argued that the uptake of sustainable management options—moving from research to practice—will depend on the adaptive capacity of the institutions and organisations responsible for governing tourism activities in the Ningaloo area. Adaptive capacity in this case is the collective ability and willingness of institutions to respond to NCC’s data and modelling results in their policy and decision-making processes.

The literature indicates, however, that despite careful research, modelling and planning, management recommendations in complex social and ecological systems, such as those being
proposed for tourism in Ningaloo, often fail to deliver as expected on the ground (Medema et al., 2008). Walters (1997) for example, cites that of the 25 major adaptive management planning exercises he has been involved in, 23 either ‘vanished’ without visible product or became trapped in an endless cycle of model refinement. Similar results have been observed in businesses aiming to improve their learning and adaptive capabilities by undertaking strategic or change management initiatives; Senge et al. (1999) note that most business-related change management initiatives fail, citing studies that show failure rates of around 70%. This institutional inertia is related to the ‘homeostatic’ nature of all organisations/institutions, in which systemic forces work to preserve the status quo in the face of new changes (Senge et al., 1999).

7.2.2 Emergence in organisations

While government departments and research organisations are not typically commercial entities they often share structural and behavioural characteristics with those kinds of bodies. This is particularly the case as these departments grow in size and scope. This means it is quite appropriate to apply the body of work based around treating organisations as complex adaptive systems to regulatory and research bodies. Seel (2008) provides an in-depth overview of organisations as complex adaptive systems. The homeostatic nature of organisations can be explained by one of the most important features of all complex adaptive systems: “their ability to self organize; for ordered patterns to emerge simply as a result of relationships and interactions of the constituent agents, without any external control or design” (Seel, 2008). The phenomena of large scale order, or patterns, emerging from small scale interactions between individual parts, or agents, is called emergence. Emergent order forms spontaneously and cannot be predicted from the properties of its constituent parts (Seel, 2008), though insight into potential emergent behaviours can be gained from looking at the co-determined effects of a system’s interactions and environment on its components (Corning, 2002; Lansing, 2003). An increasing capacity to identify points of possible emergence and its potential form does not immediately translate into managerial power. Once formed, the emergent order typically resists change and cannot be controlled (Seel, 2006), though experience in fisheries and other complex adaptive systems is showing they can potentially be managed, a subtle but important distinction. This distinction helps us understand why ‘managing’ organisations, especially via imposing controlled or planned change, is so difficult and so often unsuccessful, and why some organisations fail to significantly adjust their policy or management practices even in the face of compelling evidence to do so (for example, via research or modelling). The successes do, however, lead us to ask how emergence of new behaviours can be fostered that make organisations more responsive to changes in their socio-economic and biophysical environment (i.e. increase their adaptive capacity)?

Answering this question should begin with considering organisations as complex adaptive systems. They are made up of a large number of separate autonomous agents, each operating in its own interest but also following a set of rules, much like birds in a flock. These rules, even when very simple, change a random assembly of agents (e.g. birds) into a cohesive functional unit (e.g. a flock), a whole which is greater than the sum of its parts. Other examples include fish shoals, ant colonies, organisms, ecosystems, the stock market, and consciousness. No-one or no-thing is in charge, and yet all the necessary co-operation between the agents occurs. Attempting to change such systems using centralized control or structure will have limited effectiveness because the systems are dynamic and unpredictable from a reductionist
perspective. Instead management rules must be folded into the context of the system and from that perspective potential means of influencing (i.e. guiding or managing) the system can be identified (Fulton et al., 2010). This inclusive perspective is required because in such a complex adaptive system even a few simple rule changes modifying the interactions between the system’s constituent agents have the potential to alter the behaviour of the entire system. What computer simulations show is that certain conditions do facilitate emergence of new behaviours in complex adaptive systems, including the connectivity and rate of information flow between agents in a system, and the diversity of agents in a system (Holland, 1995; Kauffman, 1996; Langton, 1986).

As such, if there is low connectivity, diversity and rates of information flow between its people, organisations are very stable and unchanging. These organisations require little energy or information flow to sustain them, however they are not really learning or adapting because existing patterns of connection have ossified (Seel, 2006). As connectivity, diversity and information flow increase, the organisation becomes ‘energized’; it is less stable, but spontaneously more responsive and adaptive to its environment, without any centralized control or intervention. Some organisational management scholars are now suggesting that simple conversation between people (i.e. agents) is the currency of change in organisations, with conversation being the most effective mechanism for increasing connectivity, diversity and information flow between agents (Shaw, 2002; Stacey et al., 2000). Thus by increasing conversation between individuals in a system, the system’s ability to respond and adapt to change is likewise increased. An additional benefit is that such discussions also highlight alternative behavioural drivers, clarifying the context of interactions for agents in the system, and allowing for a more effective selection of management options that can help guide the system into behaviours that lead to the desired emergent outcomes (Fulton et al., 2010).

Stacy et al. (2000) argue that it is the tension between power, conflict and cooperation inherent in the relationships between people that leads to emergence in human systems. Furthermore, Seel (2006) suggests that emergence in organisations can be facilitated through people’s intention and desire to influence outcomes, and that this intention is often created as people in the system interact. However, inclusive co-management approaches are not without their potential drawbacks. For example, in applying Kaufman’s (1993) work on formative causality in systems, Stacey (1996) suggests that emergence can be inhibited by extremes (too little or much) of motivation or anxiety among people in the system, or by strong power differentials. For example, emergence may not materialise if too many people in the system are apathetic or un-empowered, or it may be suppressed by powerful people with vested interests who feel threatened by change. This helps explain why rapid institutional learning and reorganisation is most often precipitated by crisis (Berkes & Turner, 2006).

As such, it can be argued that modelling researchers should be able to increase the uptake of modelling and research results for policy and decision-making in complex, human systems, by initiating conversations–both formal and informal–about doing so among a diversity of people in such systems.

By connecting people through conversation, new ideas, behaviours, and groups begin to emerge, which can become established and lead to more inclusive and effective adaptive management in the long term (e.g. multi-stakeholder groups found in Australian fisheries management structures). A measure of the success of the researcher’s efforts is when explicit
nurturing of such connections by researchers is no longer critically needed. Researchers can also work to encourage emergence through “watchful anticipation” (Seel, 2006): watching for signs of new ‘behaviours’ in the system and, where possible, fostering facilitating factors, such as people’s growing visions and desire for change, and minimising inhibiting factors, such as excessive anxiety and control exerted by powerful and threatened agents in the system. This role must be handled with care, however: the researcher must be careful not to take on an advocacy role for only a subset of the system as other stakeholders will disengage and this will ultimately undermine improvement in adaptive capacity.

7.3 Modellers as Agents of Change: The Ningaloo Coast Case Study

The purpose of this paper is not to explain or discuss the models developed for the region, or to detail the structured process of engagement and collaboration (already covered for the NDM in other chapters, and in a separate CSIRO report for the Marine and Atmospheric Research Division). The focus here is the factors that facilitate (or inhibit) the emergence of new patterns of behaviour in Ningaloo’s organisational systems, particularly those behaviours which may improve the systems’ adaptive capacity (in this case framed as uptake of research for decision-making).

7.3.1 Challenges faced by modelling researchers

Modelling researchers in Ningaloo faced a number of challenges that made it difficult to apply van den Belt’s (2004) structured approach to stakeholder engagement. These challenges can be largely linked to tourism and other extractive industries being part of complex social-ecological systems (McKercher, 1999), and the turbulent nature of these complex adaptive systems in the Ningaloo case.

The difficulty with modelling research uptake at Ningaloo is both connected to and analogous with tourism. In particular, low connectivity between the organisations operating in the Ningaloo tourism system was one of the challenges faced by modellers. Tourism is driven by the activities and expenditure of people from outside of a region, state or country. These visitors often consume the same services and buy the same products as locals, such as using the local supermarket, fishing and generating waste, as well as purchasing leisure activities such as tours and staying in tourist accommodation. People who work in tourism are aware of this. A travel agent we interviewed in the region stated that even the funeral parlour benefits from tourism. However, outside of dedicated tourism businesses, many of the organisations that provide services to tourists do not perceive these benefits and do not see themselves as tourism organisations. This includes protected area managers and local government, organisations that generally manage the negative impacts of tourism, but receive little direct financial compensation from tourists.

Amongst businesses that provide services predominantly to tourists (booking agencies, hotels, tour operators), there are varying degrees of cooperation with few links between some businesses (for instance, a caravan park and a four star resort). This variation has led Leiper (2008) to label tourism partially industrialised, and to claim that there are many tourism industries. When this concept is extended to businesses that do not perceive themselves to be in tourism (despite influencing and being influenced by tourism), it is not surprising that there is
low connectivity between individuals and organisations across a tourism system. This connectivity is further reduced when notions of sustainability extend the boundaries of a tourism system to encompass impacts on water, waste, host communities and regional ecology. Since tourism is currently the largest economic activity and the primary generator of environmental and social impacts in the Ningaloo Coast region, it is not surprising that there are low levels of connectivity in Ningaloo’s socio-ecological system, and many grey areas associated with tourism impacts and management.

Like tourism, the broader Ningaloo Coast community has many coexisting networks with differing degrees of connectivity; as such, responsibility for negative impacts can easily fall into the spaces between these networks. Furthermore, the history of conflicts over land use between pastoralists, some tourists, government agencies, local businesses and the two shires in the region exacerbates these divisions. For example, indigenous involvement in the modelling process was not straightforward due to the politics between different groups in the region. After a two year process of attempting to engage through the native title group that includes the Ningaloo Coast, the NDM project decided to work with the Baiyungu Aboriginal Corporation (BAC) while maintaining good relations with other groups. The BAC had a clear and undisputed connection to a substantial section of the coastline: they owned a coastal property close to Coral Bay, and had opportunities to be involved with tourism development at Coral Bay through native title negotiations. While not an active participant in meetings, BAC members were happy to talk at length privately; consequently their perspectives were incorporated into the CSIRO InVitro model. Thus the indigenous perspectives had influence through model use rather than direct discussions. Although this route to inclusion reduced the diversity of conversations held within the participatory workshops supporting the model building process, and so was not ideal under the guidelines laid out by van den Belt (2004), it is another example of how the modelling process needs to be adaptive and culturally aware. Not all cultures share information in the same way and the inclusion of the concerns and perspectives of the indigenous community (in this case in the CSIRO model) is more important than sticking to a “modelling method script”.

Low connectivity between individual stakeholders was another challenging factor faced by modellers in Ningaloo. An important factor in any complex adaptive system is its initial state. The adaptive capacity of a set of organisations depends in particular on the connectedness of individual members within and across organisations, the rate of information flow, and on diversity. Circumstances can increase adaptive capacity, through crises that threaten a natural resource like a water catchment or fishery, or through the long-term engagement of a researcher with a set of organisations (as has occurred in fisheries). Unfortunately, the adaptive capacity of the Ningaloo Coast region was limited, as connectivity between individuals in different organisations was often low due to the characteristics of the industries active in the area (including tourism) and historic conflicts between different groups. Additionally, it became apparent through discussions with the tourism industry and other groups that they had few connections with the employees of agencies where information was exchanged e.g. DEC. This was reinforced by network analyses undertaken as part of the research by Peta Dzidic, Geoff Symes and Jeff Dambacher that showed that only a few well connected nodes were present in the system and that research was typically isolated from the other system members. In such a context, it is unsurprising that the early research results and modelling effort were not penetrating very far into the set of organisations that together managed tourism. Significant
efforts (described further below) have since been made to try and redress this isolation and build a more robust network of communication channels.

Sustaining effective stakeholder communication and engagement was also a challenge for modellers. The Ningaloo Destination Modelling (NDM) project was the first to initiate engagement in the region. It began very positively by following van den Belt’s mediated modelling approach. Over fifty people attended a workshop in Exmouth, which closely followed a nationally televised segment on the research by a current affairs program. The workshop was successful at defining what the model should address based on the concerns and hopes of locals, and assessments indicated the workshop successfully communicated the purpose of the project. These successes point to the potential of modelling projects to build connectivity in a system. However, despite this initial broad base of support, numbers dropped considerably for subsequent workshops, even with the wide distribution of follow-up newsletters. While the aim of the project was to operate with a broad base of public support, the NDM project focussed its time and resources on engaging a smaller group of locals from the Ningaloo Sustainable Development Office (NSDO, a regional office of the Department of Planning), the Shire, DEC, the accommodation sector, the pastoralists and some of the tourism operators. Information therefore flowed predominantly to a small number of groups on a regular basis following the initial workshop. Even with these groups, communication was every 3 to 6 months, until a member of the research team moved to the region. A related issue was the style of communication, with the content of presentations gaining clarity as the project progressed. Communicating research results was identified as a major issue part way through the project, which also affected the rate of information flow amongst Ningaloo residents.

Another significant challenge was turbulence caused by staff and agency turnover in the region. Considerable amounts of time were put into cultivating relationships with key staff members in different organisations who could champion the research in their organisations, and potentially beyond to other organisations and groups. The key organisation for much of the project was the NSDO. The NSDO was the most likely custodian for the models due to their oversight of land use planning along the coastline between Carnarvon and Exmouth (a critical process in controlling tourism development), and their coordination of regional development. The NSDO had the capacity to promote model use across organisations and feed research results into planning processes; initial discussions indicated that they would be willing to take custody of the model. However, with the change in government in 2008, funding for the NSDO was discontinued and its staff left the Department of Planning. This meant that clear delivery of modelling tools to a local champion, who would use the model and communicate its results, has become problematic. This is an on-going and increasing issue for research bodies, with Ningaloo but one example. Although there is a demand for tools that support adaptive resource management, there is often little scope within busy management agencies and businesses to adopt modelling tools (some of which require specialist skills to operate). In addition, modern funding arrangements make maintenance of such tools within research bodies problematic, with staff moving on to new questions in new locations once they finish a research project. In the Ningaloo case, new, shared, arrangements for using and maintaining modelling tools are evolving, but even this is proving to be an adaptive aspect of the model delivery and uptake process.

Staff turnover in locally-based organisations was also a problem; new staff had to be lobbied about the modelling project and educated about the methods, then their perspectives had to be
incorporated in the modelling process. Staff turnover in Exmouth was very high: only one out of six original staff in the Shire’s senior management team was present throughout the three year life of the project. Because these individuals were originally conceived as the key people for promoting model uptake in the region, their departure was a major impediment to information flow.

7.3.2 Emergent behaviours among researchers and the Ningaloo Research Program (NRP)

As researchers fronted the challenges associated with transferring knowledge in this turbulent environment, they began engaging a range of stakeholders to promote uptake of the modelling tools, thereby brokering increased connectivity and diversity between agents (stakeholders and researchers) operating in the region. Researchers also began fostering new behaviours in Ningaloo’s organisational systems that were emerging in response to this stakeholder interaction. For example, the closure of the NSDO and staff turnover in key agencies, such as the local DEC and Shire offices, led greater promotion of the research and modelling to different organisations and stakeholder groups, both at the regional and state levels. In particular, researchers renewed one-on-one contact with stakeholders in the region (via phone calls, meetings and local forums), to inform people about the model capacities, and to garner feedback on modelling scenarios relevant to stakeholders in the region, given current concerns and planning and development activities. The NRP also responded to regional concerns and needs by assessing the impacts of past and current proposals for tourism and other development. As the engagement component of the NDM project progressed, locals indicated that they had serious concerns about changes to their lifestyles, particularly leisure activities such as fishing and surfing. Leveraging concerns over lifestyle became an important way of increasing information flow and connectivity through the system. As such, interest in using the using the models to help inform planning and decision-making in the region was generated and renewed. This was further reinforced by a series of training workshops held in the region, which introduced stakeholders to adaptive management concepts and how to use the models.

Deployment of a regionally-based knowledge broker

One of the authors of this chapter, Kelly Chapman, moved to Exmouth as part of her doctoral research on research uptake. Using an action research approach, she has taken on the role of a ‘knowledge broker’ between researchers and regionally-based stakeholders. Knowledge brokering involves the transfer of knowledge between researchers, practitioners and policy makers through interpersonal relationships. Kelly’s work is examining whether stimulating conversations between different stakeholders and researchers leads to emergent –and potentially adaptive –behaviours in groups and organisations in operating in the Ningaloo region. She has been living in the region for a year, and has worked with modelling researchers to expand and strengthen connections/relationships between agents in the system (primarily between researchers and local people/agencies). She has also conducted 35 stakeholder interviews which explored barriers and opportunities related to the knowledge transfer process, and identified current issues that could benefit from modelling/research.

In a bid to mainstream Kelly’s work into their ongoing management of the NRP, the research committee invited her to participate in monthly research committee meetings and other planning activities. This opened a new and important conduit between the region and the NRP, as Kelly
has been able to use these opportunities to channel stakeholder concerns and suggestions directly to the research committee. Kelly has also passed along stakeholder advice on how they want to be communicated with and how they want the research results formatted and delivered. Other researchers with direct contact with regional stakeholders, including the other two authors of this paper, have likewise been able to channel advice back to the NRP.

Kelly’s long-term presence in the community also helped researchers tap into regional communication networks and identify potential locally-based partners for assisting with knowledge transfer in the region, most notably the Gascoyne Development Commission (GDC). The GDC is a key player in the region because they are viewed locally as relatively neutral (unlike DEC or the Shires), and because they have a strong network of relationships with all of the region’s key stakeholder groups.

**Improving communications**

As modelling researchers engaged with local groups, they worked to improve the clarity of their presentations by using common language and easy to understand formats, and by tailoring the focus of modelling results to be relevant to the interests of specific audiences. This involved speaking and meeting with stakeholder groups (often using Kelly in her knowledge broker capacity) to identify topics of interest prior to coming to the region to present the models. Kelly’s prior experience as a science communicator assisted this process greatly. This experience has also enabled the modellers guide other researchers in making their research findings more accessible to the local community, who have often complained about not seeing any return for the support they give to those conducting research in the region. Additionally, CSIRO’s Communications section developed a communications strategy to help reach agencies and a broader audience. The communications strategy was also an opportunity to garner advice from regional stakeholders (via a Regional Reference Group – discussed below) on how to best engage people in the region. As the communications plan is not yet complete or implemented, the actual extent of local involvement in the strategy’s development and delivery has not been fully determined.

This innovative activity on behalf of the researchers constitutes adaptive/emergent behaviour. However, as these actions are not generally perceived to be the traditional role of a research committee they did meet resistance, as predicted by the work of Seele (2008) and Senge (1999). This resistance is described in a later section.

**7.3.3 Emergent behaviours among groups and organisations in the region**

As the NRP engaged local stakeholders, the connectivity, information flow, and the diversity of groups engaging with the modelling research increased. This became most effective once an ongoing regional presence, via Kelly’s role as knowledge broker, created or renewed connections through many local conversations. The modelling team needed to be able to make enough meaningful connections to generate new ideas, then to use regional networks to increase their penetration into the community and local organisations. As a result, a number of emergent behaviours arose among groups and organisations in the region. Although we have separated the novel behaviours emerging in the NRP and the region for the purposes of this discussion, it
should be noted that these behaviours actually evolved synergistically and in dynamic response to each other as a result of increased connectivity between the agents of both systems.

A suggestion generated through Kelly’s conversations with stakeholders was for a part-time regional research coordinator, to work with stakeholders to promote research more broadly in the region and to ensure use of the models regional planning and assessment processes. This suggestion was initially funded through three NRP projects. The GDC saw an opportunity to link the coordinator position to one of its proposed projects, the Ningaloo Research Centre (a regionally-based educational research facility) and offered to sponsor and help fund the role. Importantly, this decision also created an opening for the GDC to become more formally involved in the NRP’s knowledge transfer process.

Further conversations between Kelly and locals led to the formation of an informal Regional Reference Group that involved, amongst others, the Exmouth Chamber of Commerce, the local conservation group, the GDC, DEC and the Exmouth Visitors Centre Marketing Committee. This created a new set of connections across institutional boundaries. The Regional Reference Group provided suggestions for regional roll-out of the NRP communications strategy, suggested content for regional communications, promoted local presentations and provided advice about the timing of events. The group also made the decision to link the research coordinator position to the reference group, by making the coordinator its chair. Information generated by the research began to circulate more broadly and more often through this group and through Kelly’s activities.

Where a set of organisations are involved, as is the case for Ningaloo tourism, the modelling also needs to generate new connections between the organisations if it is to build regional capacity to effectively use the modelling tools and the research. The Regional Reference Group is an example of how this can happen. This group has the capacity to become an ongoing informal ‘community of practice’ (Wenger, 2005) that facilitates the interface between science and management in the region. Such an umbrella group could also potentially provide coordination across planning processes and management decisions. Running a modelling project from outside a region may be possible if there is a small committed group of locals involved and there are well-structured, regular meetings. In our case, a regional presence made a big difference to both connectivity and information flow.

As a result of these emergent behaviours, there does appear to be some preliminary uptake of modelling and research in the Ningaloo region. Rounds of meetings between researchers and stakeholders appear to be generating some interest in using the models for decision-making in the region. Discussions are underway about using the models to help inform different planning processes taking place in the region. Notably, one of the Shire’s has expressed interest in using the models for a community visioning process, and some stakeholders have expressed an interest in using the models as a tool to facilitate multi-stakeholder discussions and decision-making in relation to planning and development proposals. Another consequence of broader engagement in the later regional forums was that some locals began to push for a review of the recreational fishing regulations, which would have been unlikely if broader scale engagement had not been done.

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20 It should be noted that the two Visitors Centres had been closely involved in the research, but this required re-engagement following manager turnover in Exmouth and Carnarvon.
In addition, some stakeholder groups have asked for training on how to use the models and in adaptive management. There is also a lot of interest in seeing the models housed locally, together with a locally based modelling support person (possible the Regional Research Coordinator). The GDC and the Ningaloo Research Centre have been suggested as suitable regional hosts for the models.

7.3.4 Factors that inhibited emergence

As these new behaviours began emerging among groups and organisations in the region, they were countered by a number of inhibiting factors. Some of these have been mentioned and all were largely related to the gap between the traditional composition, role and operation of a committee providing research oversight, and the kind of committee that can respond most effectively to emergence arising from research activities. Although our research committee was flexible in its approach, recognised the importance of local engagement and communication, and was prepared to invest additional resources to encourage research uptake, it is still worthwhile examining the particular structural issues that inhibited emergence.

The new set of activities that followed Kelly’s entry into the region were supported by the research projects’ management team, although this was not without tensions. Historical tensions between agencies and stakeholders in the region created anxieties about affiliating the NRP with a regional group consisting of polarised stakeholders. This was particularly so given the potential for conflict over negotiations for the excision of the two kilometre coastal strip from the pastoral stations (the excision itself being a ‘wicked’ problem). Concerns related to the make-up and purpose of the reference group, and who, if anyone, would control it. Start-up of the regional research coordinator position was also delayed due to concerns in the research committee. The first candidate who had experience in similar roles eventually chose not to take the position due to delays in the appointment process. A later candidate pulled-out, in part because of concerns about political concerns associated with the role.

Moving from research management to research uptake

Anxiety within the research committee restricted its capacity to move on emerging opportunities for knowledge transfer in the region. The composition of the research committee reflected its purpose—managing the progress of the research projects. It was comprised of senior researchers, project leaders, and later in the project communications officers and researchers with links to the local communities. Local groups were not represented, so anxieties over new activities in the region were not balanced by assurances from regional organisations on the potentials of these new opportunities. This lack of proportionate power slowed the diffusion of anxiety.

The major issue, however, was not so much the concerns noted above (although these are pertinent), but the rate at which information flowed back to the region. Once new activities began to emerge, the research committee and researchers were generally supportive, but tended to respond slowly through monthly meetings, with concerns sometimes only being raised in subsequent meetings. Research institutions tend to move slowly in response to new opportunities (i) as their role is perceived to primarily be in research oversight and (ii) because their attention is divided between that particular body of research and the many other projects and responsibilities they have. It is worth noting that these delays arose despite the research
committee’s flexible approach and willingness to adapt to take advantage of new opportunities and are potentially unavoidable, given the nature of modern research bodies. Generally, the impetus for change in the region moved much more quickly than the research committee and had slowed by the time the committee came back with decisions, which were supportive of regional initiatives.

Tensions between adaptive and more staid organisational structures also arose around the development of a communications plan. Institutional protocols (designed to keep relevant regulatory and ministerial bodies informed, and avoid potentially politically embarrassing situations) mean that there is typically a high degree of “in-house” control over public relations processes. Consequently, local and researcher involvement, outside of management committees, tends to occur once the plan is fully formed, rather than through a process that occurs across the development of the communications plan. Unfortunately this can restrict connectivity, and impacts upon the potential uptake of the information, reducing the likelihood of information circulating broadly if regional stakeholders (and the community more broadly\textsuperscript{21}) do not feel engaged.

\textit{Structural limitations of the current research model}

A second point of local interest was the Ningaloo Research Centre. The proposed Research Centre was backed by the GDC and had strong local support and a board with excellent community networks. However, universities and researchers wanted little to do with the Research Centre due to concerns over the ongoing funding that buildings require, and the important concern that institutions may not have research funds to commit to an ongoing program in a single location. Institutional sensitivities are acute around liabilities associated with whether or not a body is a legal entity, and are linked to past experience where other informal bodies showed much promise, but never made it to an independent, self supporting status and collapsed (even after considerable injection of funds, effort and time). While researchers did provide advice about how to attract researchers and ongoing funding, researchers chose not to pursue the proposed Research Centre as an opportunity to promote research in the region and engage with regional organisations.

Finally, the ephemeral nature of research programs also impeded emergent behaviours in the region. Just as regional tourism and extractive industries can be conceived as complex adaptive systems, tourism and research also form a complex adaptive system, with an important control variable being the research funding cycle (a slow moving variable). The adaptive cycle of research has its own ‘collapse’ phase, where researchers consolidate their activities at the end of a project while looking for the next research opportunity. Unfortunately, researchers wind down their engagement with the region at the time when their research is most likely to stimulate adaptive behaviour. Based on the poor uptake of some of its previous research, CSIRO was aware that opportunities for research uptake and ‘impact’ can be lost in part because of the shifting focus of researchers. Consequently, CSIRO has provided additional funding to ensure that the model promotion, training and use will continue beyond the life of the project. Nonetheless, this funding has a limited lifespan and CSIRO is looking into other collaborative

\textsuperscript{21} It is worth remembering that in small population centers, such as those in the Ningaloo region, the local community puts a good deal of weight in local representation and distrusts external influences. Thus disaffection of local representative with the engagement process can have a cascading effect across community attitudes, in a way that would seem disproportionate in larger settlements where there are many competing information networks and representational bodies.
long-term solutions. As much of the information flow in the Ningaloo system has relied on preliminary results (and needs to as stakeholders will not remain engaged if the modellers “go silent” for years as they work to final model results), the continued funding ensures ongoing connectivity and information flow until the final research results are available, and perhaps beyond.

Modellers are still absent from the region for long periods, an issue that will only be resolved if the models are located in the region where they can be accessed by locals, or a regionally based facilitator. Regional training workshops on how to use the models met with mixed success. Training in Exmouth and Perth was well received, but there was poor attendance in Carnarvon due to a variety of events occurring on the days of the training that had implications for many of the invitees, and a training event for the pastoralists in Coral Bay had poor attendance, in part due to the two floods and cyclone that occurred in the region in the three months preceding the workshop date in early February 2011. The structural limitations of research need to be viewed alongside the difficulties of engaging with potential model users who are busy and have multiple roles and demands.

7.4 Conclusion

As connectivity between regional groups and organisations and the researchers increased, new behaviours emerged in two contexts. In the region, the configuration of stakeholders in the regional reference group indicates a new attitude to engagement with each other and with researchers, as does the GDC’s willingness to work with research organisations to sponsor the regional research coordinator position. The set of organisations that manage tourism in the region have now become more change ready. Emergent behaviour is also evident in the research committee, through willingness to work with the regional initiatives, and the development of a communications strategy.

Increasing the diversity of agents interacting in a system is also relevant. Modellers often use participatory modelling approaches and techniques such as Role-playing Games and Agent-based Models to collate multiple stakeholder viewpoints in their conceptual models (D’Aquino et al., 2003; Dray et al., 2006; van den Belt, 2004). Modelling of social ecological systems needs to bring together a diverse group of locals in order to capture impacts and conflicts that are overlooked in the current configuration of regional organisations. In some cases making these connections was relatively easy, such as demonstrating how building approvals in Exmouth impact on the national park. The Regional Reference Group was an important meeting point for diverse groups with a focus on new information and change. Bringing in diversity through involving Indigenous groups was more difficult.

The need to take advantage of emergence before the opportunity is lost is best expressed through Seele’s concept of watchful anticipation (2006). The structure of most modelling projects will cause them to struggle to take advantage of emergent behaviours. Events need to be closely monitored, and responses need to be quick to encourage new behaviours. However, modelling projects and the research committees that oversee them tend to be focussed on the quality of the research and meeting milestone. As such, they struggle to move quickly when opportunities present themselves. The NCC committee was adaptive despite only having a small number of staff with limited time and funding for extension activities. Nor surprisingly, it struggled to move quickly when these opportunities arose. If modellers are to be change agents,
modelling projects need to encourage the optimum conditions for emergence and be structured to ‘watchfully anticipate’ new behaviours. The modeller needs to be well and regularly connected to enough organisations with enough diversity to begin the process of change. Research information needs to flow through this network, through to local networks where a broad section of the set of organisations hear and understand the results. This will only happen if the information is locally relevant, through leveraging issues of local concern.

One approach that provides modelling projects with some significant degree of responsive flexibility is to use sets of complimentary modelling tools, with varying degrees of complexity. Large complex models may remain a necessary part of modelling exercises as their inclusive form can identify system dynamics and tradeoffs missed in simpler models. However, their large size (which requires specialist interpretative skills) and slow time to delivery means that stakeholders will not remain engaged if they are the sole tool used. Complimentary simpler models are needed to maintain engagement, educate stakeholders on the role and usefulness of models and facilitate communication (which may lead to new behaviours that in turn need to be adaptively brought into the modelling process). Such a hierarchy of components is central to complex adaptive systems and highlights what the modelling process must become.

In addition to these technical approaches, connectivity can be directly increased by including stakeholder representatives on the research steering committee. This has been successfully used within the fisheries realm [e.g. for the analysis of potential management options for Australia’s commonwealth fisheries (Smith et al., 2007)] with the effectiveness of the body arising from the direct awareness of committee members of attitudes and issues pertinent to the broader stakeholder community, and culturally appropriate engagement strategies. There also needs to be proportionate power on the research committee, so that one set of concerns does not dominate, which would affect the representative nature of the committee, impact engagement of the other stakeholders and slow the committee’s response to emergent behaviours. In addition, there must be avenues for quickly resolving anxieties among powerful agents if and when they feel their interests are threatened by emerging behaviours. Most importantly, the modeller and the research committee need to be ready for emergence, and have the capacity to respond quickly to take advantage of these opportunities. This would be a departure from most current academic oversight committees, which are quite appropriately focussed on delivering research outcomes on time and within budget. The adaptive modelling project would be constantly monitoring local change, and be watchfully anticipating emergent behaviours.

Emergent approaches, where modelling researchers serve as change agents by using conversation to ‘feel’ their way through stakeholder engagement, are an alternative and complimentary process to the planned and structured stakeholder engagement process outlined by van den Belt (2004). In practice the two will need to be used together. While van den Belt’s approach makes sense when working with well-defined stakeholder groups with a history of working together and a clearly defined problem domain, emergent approaches may prove to be more realistic and practical in more turbulent situations where structured engagement processes may be frustrated by the dispersed, polarized and/or fluid nature of the stakeholder groups and the ‘wicked’ nature of the problems involved.
7.5 References


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Assessing the impact of stakeholder engagement in Management Strategy Evaluation

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Abstract

After completing a large, regional, multi-use Management Strategy Evaluation, we attempt to assess the impact of stakeholder engagement on the project. We do so by comparing the original project plan to the actual project development and highlight the changes which can be more directly related to stakeholder engagement. The impact can be summarised into four broad classes: a) a measurable change in the network of interactions both among researchers and stakeholders; b) changes in how the computer model was developed and run; c) changes in attitudes both among researchers and stakeholders and d) change in the actual project development. We discuss these changes, the way they have been detected and some lessons we learnt which may benefit future Management Strategy Evaluation projects.

1. Introduction

Adaptive management is a way of managing resources as a series of iterative experiments, through which managers and institutions learn (Holling, 1978; Walters, 1986). However, there are two critical challenges associated with practicing adaptive management. Firstly, resource management problems are typically complex social-ecological system problems (Levin, 1999). Because of their complex feedback loops and their intertwined, dynamic, and uncertain nature, the workings of these systems often far exceeds the limits of human rationality, and as such, managers will inevitably make suboptimal decisions in these circumstances, due to lack of information and their inability to rationally process what information they do have (Simon, 1979; Hogarth, 1987; Ehrlich, 2000). Secondly, because of their complexity, resource management problems are also ‘wicked’ problems that are very difficult to define and resolve and typically span a myriad of disciplines and stakeholder interests (Rittel et al., 1973). Wicked problems have no optimal, right or wrong solutions (only better or worse from the viewpoint of different stakeholders), which, once implemented, have significant and far-reaching impacts, thereby rendering trial-and-error learning undesirable or impossible (Rittel et al., 1973).

Management Strategy Evaluation (MSE) is a framework for helping management agencies and stakeholders make informed decisions, one which is well-placed for addressing the above-noted challenges. Firstly, MSE helps humans deal with system complexity by using computers to model the dynamic interactions within and between the natural and human systems under examination. Secondly, MSE uses computer models to simulate the different steps in adaptive management framework (Butterworth et al., 1998; Cochrane et al., 1998; Butterworth et al., 1999; Sainsbury et al., 2000), and to assess performance and tradeoffs of different management strategies within these complex socio-ecological-economic systems. In this capacity, MSE projects allow the desirability of different management strategies to be assessed in the ‘cyber’ world before trialling them in the ‘real’ world. Thirdly, engaging different stakeholders in designing the models, formulating problems and assessing different
strategies can ultimately lead to on-the-ground improvements in collective problem-solving and decision-making (D’Aquino et al., 2003).

Because the cooperation of many stakeholders\(^1\) is needed to ensure the MSE model is actually used to assist with decision-making, and because, if used, the model will influence decisions affecting the lives and livelihoods of many different people, a stakeholder engagement process is needed if the project is to be both successful and ethically sound.

From a project management perspective, stakeholder engagement is likely to have considerable impact on how an MSE project unfolds, thereby presenting a number of challenges for budgeting and planning. When stakeholder engagement is carried out within a MSE framework, a modelling team usually applies a number of different strategies or actions, which include determining who the stakeholders are, explaining what models can offer, collecting information, understanding expectations, defining modelling questions and system indicators that are relevant to stakeholders, learning the most suitable way to communicate information and building trust, ownership and participation. However, our experience has shown that there is no clear one-to-one correspondence between such activities and achieving the goals of a MSE project. Nor is there a standard recipe for executing such strategies that can be successfully applied in all situations, as evinced by the limited application van den Belt’s (2004) structured, three-stage ‘mediated modelling’ approach had for this study (Chapman et al. 2011). The composition, influence, knowledge, motivations and actions of stakeholders are ‘turbulent’, meaning they differ for any given place and for any given time, with groups forming complex and ever-changing webs of relationships which are inherently uncertain. Human relations, trust and mutual understanding, which are preconditions for cooperation (Putnam, 1995; Wondolleck et al., 2000), are not obtained in a one-off effort, but take time and repeated reciprocal interaction to develop (Pretty et al., 2001). Pinning down stakeholder systems can also be frustrated by the fact that the modellers themselves affect the stakeholder system – as soon as they begin engaging, stakeholders’ perceptions, knowledge and actions begin to change in response (see Heisenberg (1930), and Capra (1997)).

In this work, we examine the effects of stakeholder engagement on the roll-out of a large, regional, multi-use MSE project in North of Western Australia. Stakeholder engagement for this project was part of a larger knowledge transfer initiative working to improve research and model uptake and bridge the science-management gap in the region. The engagement process we discuss was not planned at project inception, rather it emerged over time in response to stakeholder needs and suggestions as the engagement progressed and it reflects the adaptive nature of the project. A more detailed description of how modelling researchers adapted to socio-political turbulence in the region by adopting an emergent approach to knowledge transfer and model uptake is outlined in Chapman et al. (2011). In addition, in-progress research due for completion in 2012 (Chapman, personal communication) will provide an evaluation of how stakeholders’ knowledge, practices and networks changed as a result of stakeholder engagement and the wider knowledge transfer process. As such, this paper specifically focuses on how stakeholder engagement affected the roll-out of the MSE project, in particular its effect on: a) actual project development, b) how the computer model was

\(^1\) A widely accepted definition of ‘stakeholder’ is provided by Freeman (Freeman, R.E., 1984. Strategic Management: A Stakeholder Approach. Pitman, Boston.) as “any group or individual who can affect, or is affected by, the achievement of a corporation’s purpose.” In the instance of MSE, the ‘corporation’ can be defined as the MSE project team.
developed and run, c) the network of interactions both among researchers and stakeholders, and d) attitudes of both among researchers and stakeholders. We discuss the implications of these effects from a project management perspective, and provide some preliminary indications as to the apparent influence of these effects on the actual purpose of the MSE project – that being to help managers and stakeholders make informed decisions. These longer-ranging effects of stakeholder engagement on model uptake and decision-making in the region will be described in greater detail in Chapman’s forthcoming thesis (in progress).

2. Ningaloo-Exmouth research

Ningaloo reef and Exmouth Gulf lies within the Gascoyne region of Western Australia (Figure 1). The area is sparsely populated (7744 according to the last census in 2006 in an area of 52,925 square kilometres), with its settlement sites largely a result of the pattern of development of the pastoralism industry, with the exception of Exmouth which was built to service the Harold E Holt Naval Base in the 1960s. The pastoral industry, which still makes up 80% of the land tenure, began in the late 1800s, when wool from the region was shipped to national and international markets. Today the economy is diversified – including tourism, pastoralism, oil and gas and many other sectors. The region is the focus of high tourism visitation due to its exceptional beauty; based around a 300km fringing coral reef along the coastline and Cape Range National Park and recreation on pastoral stations on land. Increasing industrial development in the broader northwest of Australia, largely based around oil and gas extraction and mining, is also providing new challenges and potential futures for the region. This close geographic association of the Ningaloo Reef (listed in 2011 by UNESCO as a World Heritage Area), other reserves (including Cape Range National Park), tourism and the diversity of local activities (including farming, fishing and oil and gas exploration) mean that any future development must be done carefully if the region’s natural resources and attractions are to be maintained and unintended consequences avoided. The region was subject to a large research programme from 2007-2011 to provide the information required for science based management decisions about the future of the region.
3. Assessing impact

Assessing the impact of decisions and actions is needed to determine their effectiveness as well as possible undesired implications. Businesses and local government routinely use several methods following a growing attendance to accountability in the public domain (Bovens, 2006).

The impact of an action can be judged by measuring its consequences. We call this Question 1. In our case, we could ask how many people attended a modelling workshop, how many people requested to use our model or how many scientists cited our report. There are two drawbacks with this approach: first, we are unable to evaluate the final actual consequence of these actions. For example, we are unable to judge whether attending our workshop had any real impact on the attendees. Second, we may include unwarranted impacts. If our model had not been developed, a stakeholder may have employed a different (but similar) model with no measurable difference in consequences.

The latter observation suggests a different approach. Inspired by an ideal definition of impact (Wolpert et al., 1999; Boschetti, 2007), we can ask what has occurred which would have not occurred had a specific action not taken place. We call this Question 2. In our case, this implies asking how different the outcome of this project would have been, had no stakeholder engagement occurred.

Since Question 2 involves a counter-factual (the impact of an action which did not happen), answering it precisely is obviously impossible. However, numerical experiments in a wide
range of problems suggest that even a largely approximate answer to Question 2 can be much more effective that a precise answer to Question 1 (Wolpert et al., 2004; Boschetti et al., 2008a). Some possible implications of this approach for human behaviour are discussed elsewhere (Boschetti, 2007).

In this work we adopt Question 2 as a guide to assessing impact. We analyse the original MSE project plan and assume the project would have developed along those lines. After project completion, we highlight the differences between how the project actually developed and the original plan. Among these differences, we focus on the ones which can be most directly attributed to stakeholder engagement.

The above question can be framed within the Integrated Figure of Merit for public good research with multiple stakeholders (Geisler, 1996), according to which research (or modelling) outputs can be thought of in terms of four temporal and conceptual classes: a) immediate (in our case publications, other measurable research outcomes and changes which can be detected promptly in the system), b) intermediate (in our case whether the model is used, whether the MSE approach is adopted or whether model results are requested and accounted for in decision making), c) pre-ultimate (in our case, specific management activities that can be demonstrated to have occurred from the MSE implementation) and d) ultimate (the role of this project in achieving overall community benefit).

This paper is written in coincidence of the immediate stage and consequently concerns this type of results. It is also reasonable to assume this approach would become less and less reliable the farther in time from project completion we analyse events. Longer-term results can be monitored using an influence diagram, tracing model use through differing levels in the stake-holders network as described in (Geisler, 1996), or via an analytical hierarchy process, as suggested in (Syme et al., 2006). A discussion of how this approach could be extended to longer-term impact is also given in Section Error! Reference source not found. below.

4. The engagement process

Figure 2 summarises how the stakeholder engagement was expected to occur at project inception. Stakeholder interactions were expected to happen mainly a) at the beginning of the project, when local information is collected and modelling objectives are discussed and simulation scenarios designed, and b) in the last stage of the project, when model results are delivered. This captures the initial perception different parties may have of the role of modelling within a MSE. For example, modellers may see the model as the final outcome of their effort and stakeholder engagement as a step in order to define, for example, what the model should do and how it should look. Non-modeller scientists may see the aim of modelling in model results, which can feed into other projects; decision makers may focus on result interpretation and consider stakeholder engagement as a natural consultative process. For each of these parties a model is a) defined early in the project, b) implemented (built and parameterised) during the project and c) fulfilled (via model runs, output generation and interpretation) at project completion.
Across other stakeholder groups there may be both different and diverse expectations. Some groups may even be hesitant, sceptical or suspicious of model use in a MSE framework. Others may have a more integrated view; they concern themselves with the inclusion of local knowledge and with the model’s fate after project completion (will the model be updated and will new information be included?). For some of these parties, model definition and development happen during the overall project as well as after its completion. This view goes to the core of the MSE and the adaptive approach. Adaptation is not only fundamental to decision making, but also to the core of MSE.

This leads to viewing model development and stakeholder engagement as an iterative process in which a) the model shifts in complexity and in focus as the problem is better defined; b) stakeholder engagement increases in depth while the stakeholders improve their appreciation of what modelling can provide and trust in the process and c) modellers better understand how to relate to stakeholders and their concerns. This results in a number of feedback loops between modellers and stakeholders as in Figure 3.
itself and evolve according to the project needs. This is particularly important when working in turbulent social-ecological systems, such as that found in Ningaloo (Chapman et al. 2011). Because these systems are always changing in unpredictable ways, detailed plans developed at the beginning of a project will quickly lose relevance and become outdated.

Figure 4 summarises the actual engagement actions taken by the modelling team during the project. Early stakeholder engagement was initiated before project commencement by properly designated staff. Unfortunately, staff turnover and illness interrupted this process; two years later the modelling team restarted and carried out the process directly. This has included several one-to-one meetings, workshops with other scientists, local and state government organisations and local communities. In particular, a total of 7 trips were taken to the Ningaloo region by different team members. These interactions between team members and stakeholders allowed for model improvement and acceptance, and also helped highlight the questions the model needed to address. Pivotal to community engagement was the extended presence in the region of a PhD student with professional experience in stakeholder engagement, and science communication whose effort not only filled the gap between local community and the research team, perceived as outsiders, but also informed the modelling team of the need to establish relationships and build trust with local stakeholders as a means of encouraging some level of local acceptance and ownership of modelling research, and possible ways of achieving this.

Figure 4. Actual stakeholder engagement process, as carried out during the project. Items above the time line indicate interaction between modellers and stakeholders; items below the time line indicate interaction among modellers and other researchers. Filled boxes indicate actions which directly involved model use or development. Accents indicate interaction which occurred in the Ningaloo region.
Moving from an engagement process as in Figure 2 to one as in Figure 3 involves not just considerable adjustments to the project plan but also change in priorities and effort allocation. While no staff had been specifically allocated to stakeholder engagement over the entire project, at the time of project completion a considerable amount of effort was dedicated to organising meetings, workshops and related travelling, and initiating and following a considerable flow of e-mail and phone communication. According to a rough estimate, stakeholder engagement accounted for approximately 43% of the effort of the overall modelling team, the remaining going to data collection, model development, and parameterisation and result visualisation. Clearly, assessing who and what will influence the impact of the model as a decision-making tool (recognising that this will continuously change from project start to finish and therefore must be continuously tracked), and cultivating and maintaining essential relationships accordingly, requires a significant investment of time and resources over the entire length of the modelling project. It also requires considerable skill and experience on the part of those conducting the engagement. This obviously highlights the importance during project inception of properly planning for the capacity, time and resources needed for stakeholder engagement, and understanding the characteristics of the locations and organisations that will be targeted for engagement.

5. Understanding the stakeholders groups

The stakeholders related to this project were particularly diverse and could be roughly grouped into three classes: a) decision makers from local and state government agencies, b) local community and tourists and c) researchers. The latter should be considered stakeholders of the MSE because several research projects were related to the modelling effort either as data providers or as beneficiaries of the model results.

The original stakeholder engagement was designed based on three premises; first, that stakeholders had an approximate idea of what questions the model had to address and that few specifically-designed meetings would suffice to define them in detail. Second, that while some stakeholders may question the scientific validity and real-world relevance of computer modelling, their understanding of the modelling activity was sufficiently well defined. More specifically, while the modelling team expected that it needed to explain the meaning of MSE and the role of modelling within it, it also expected that why and how we model could be taken as well understood. Third, it expected that basic understanding of system functioning was also well understood and that communication to the non-scientific audience needed to focus mainly on complex information, like the impacts of feedbacks loops among different sectors, the effect of interactions in large ecological networks and other counter intuitive processes which may affect the Ningaloo region.

The latter assumption, according to which most stakeholders had a reasonable understanding of basic system dynamics, is important since the understanding of the model result rests necessarily on such basis. Midway during the project, we become aware of recent work highlighting how decision makers’ and public misconceptions of accumulation and feedback processes may affect the types of policy they implement and support (Moxnes, 1998; Moxnes, 2000; Sterman et al., 2002; Sterman et al., 2007; Sterman, 2008; Cronin et al., 2009; Moxnes et al., 2009). We thus decided it was important to verify such understanding within our stakeholder group and we designed a questionnaire for this purpose. Our results are discussed in (Boschetti et al., 2010; Boschetti et al., 2011b). Two results are of particular interest. First, our data confirm the estimates reported in the literature (ref): between 65% and 70% of interviewed people show difficulties in understanding basic stocks and flows processes (Sweeney et al., 2000; Sweeney et al., 2007; Sterman, 2008), which, in the context of our application, could result in overfishing (Moxnes, 1998), overexploiting other limited resources, or overdeveloping. Checking for the occurrence of these cognitive difficulties is important because overexploitation is usually associated with either greed or lack of
environmental and community concern (Moxnes, 1998; Moxnes, 2000); policies designed to target cognitive misunderstandings of natural process or purposeful overexploitation can be considerably different. Similarly, misconception of causal effects due to feedback loops also holds potential implication for suggesting and supporting ineffective policies (Dorner, 1996; Sterman, 2008). The second interesting result is that performance of scientists, decision makers and the general public on these tasks was barely distinguishable (Boschetti et al., 2010; Boschetti et al., 2011b). While apparently surprising, this result also matches data found in the literature of expert knowledge (Camerer et al., 1991; Ericsson, 1993; Dorner, 1996; Tetlock, 2005). The main conclusions from these two observations are that a) even simple models designed to aid decision making tasks can provide a means to prevent common cognitive fallacies, b) modelling can provide training to develop our intuition on system functions and c) these tools are useful to both experts and non experts.

Cognitive abilities do not live in a vacuum; rather they are influenced by cognitive styles (the way we approach a problem and the amount of effort we are willing to dedicate to it) and interact with worldviews and attitudes in shaping our choices and decisions (Boschetti et al., 2011a). A second type of questionnaire was used to assess the stakeholders’ world views, that is, perceptions of how the world functions and the values they hold. This was motivated by literature showing that people tend to polarise according to specific beliefs which affect not only their decision, but also the way they process and filter novel information (Duckitt et al., 2002; Unger, 2002; Lewandowsky et al., 2005; Heath et al., 2006; Kahan et al., 2007; Mirisola et al., 2007; Duckitt et al., 2009). Effective communication of research results may need to be tailored according to such beliefs. According to (O'Riordan et al., 1999; Leviston et al., 2010a), these beliefs can be broadly summarised into 4 statements:

a) The environment is fragile and will only be protected if there are large changes in human behaviour and society.
b) The environment can be managed by the government and experts if there are clear rules about what is allowed.
c) The environment can adapt to changes and technology will solve environmental problems eventually.
d) The environment is unpredictable and we can't control what happens.

We asked this question to two types of stakeholders: a) ‘Workshop Attendees’, participants who attended our modelling workshop, which include fishers, tourism operators, educators and local government representatives based both within and outside the Ningaloo region; b) ‘Ningaloo Public’, participants who attended our public presentations. This group includes both people based in the Ningaloo region and tourists. The vast majority of the stakeholders we interviewed subscribe to Belief a (environmental management is a social problem), with a minority subscribing to Belief b (environmental management is a governance issue). Very few stakeholder subscribed to Belief c (environmental management is a technological/economical problem) or to Belief d (environmental problems are hard or impossible to manage).

It is reasonable to suspect that such skewed results are a consequence of the voluntary nature of the participation to our workshops and that a less environmental-oriented result would be obtained if a larger section of the population was interviewed. In order to check this we ran the same questionaries via an on-line survey targeting two different groups not related to the Ningaloo region: a) ‘General Public’ (116 people), which includes participants not residing in the Ningaloo Region and not involved in scientific research and b) ‘Researchers’, participants not residing in the Ningaloo region but who were involved in scientific research. As shown in Table 1, the responses to this question become more homogenous moving from the Ningaloo Public, to Workshop Attendees, to Researchers, to the General Public. In particular the choice “The environment is fragile and will only be protected if there are large changes in human behaviour and society” becomes less and less prevalent. The difference in responses between
participant groups is statistically significant (pValue=0.1), except between ‘Workshop attendees’ and ‘Ningaloo Public’.

Finally, we compared our results to large national survey on attitude towards climate change (Leviston et al., 2010b) (bottom row in Table 1). This differs significantly (pValues ≈ 0.01) from all other responses. Particularly noticeable is the much higher prevalence of Belief d (The environment is unpredictable and we can't control what happens) in the large national survey compared to the groups we interviewed. This is encouraging, since it suggests a much stronger belief on some level of human agency on the fate of the environment in our stakeholders.

We summarise this section by highlighting the main impact which occurred from gaining a better understanding of the stakeholder group. First, the awareness that when dealing with system dynamics, intuition can be misleading and it can affect even experts, leads us to implement a number of simple models to address this challenge (Dorner, 1996; Moxnes, 1998; Moxnes, 2000; Sterman, 2008), as described in Section 7 below. Simple models can be very useful not only in checking basic assumptions on how systems works and how our decisions may affect them, but also in providing basic training to develop an intuition for general system dynamics, which can then be employed in thinking about specific problems. Second, these simple models can be used in interactive mode in public sessions, during which basic scenario developments or interventions can be discussed, projected in the future and then modelled in real time to provide a dynamical check on the projection. Our experience is that the learning and discussion arising from these public sessions can be pivotal in generating change in certain stakeholder groups. Third, the communication style used during both technical workshop and public presentations has changed during the project, focussing on the type of audience and accounting both for cognitive styles (that is presenting information in a format which can be easily understood) and attitudes (in order to prevent alienating the audience). Fourth, some forms of interactions have been repeated a number of times to increase effectiveness. It is unlikely a single act of communicating a piece of information is going to reach all stakeholders. Finally, we tried to test whether learning occurs by using simple models. During our workshops, we used post-workshop questionnaire to get a subjective evaluation of this learning, which appears to be positive. However, we also ran a more objective test with university students. The purpose of the test was to see whether improvement in a complex task was obtained by first training the students with simple dynamical models. The results are discussed in (Boschetti et al., 2011b) and, despite the small sample of student employed, are encouraging, suggesting that this is a field of research which is worth pursuing. Importantly, a much more deep learning has occurred within the research team. This has resulted in a batch of models (Fulton et al., 2001) and a specific questionnaire (Boschetti et al., 2011a) has been designed as a result of this research which we plan to formally incorporate in future MSE projects.

Table 1. Responses from the worldviews and attitudes question for different audiences related to the Ningaloo Research Project and from the general public as surveyed in (Leviston et al., 2010b). For each of the statements in the questionnaire (a-d) we give the percentage of people who agreed with them.

<table>
<thead>
<tr>
<th>Audience</th>
<th>Belief a</th>
<th>Belief b</th>
<th>Belief c</th>
<th>Belief d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop attendees</td>
<td>91%</td>
<td>5%</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>Ningaloo public</td>
<td>68%</td>
<td>26%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Researchers</td>
<td>51%</td>
<td>35%</td>
<td>3%</td>
<td>11%</td>
</tr>
<tr>
<td>General Public</td>
<td>38%</td>
<td>26%</td>
<td>25%</td>
<td>11%</td>
</tr>
<tr>
<td>Large national survey</td>
<td>50%</td>
<td>15%</td>
<td>13%</td>
<td>22%</td>
</tr>
</tbody>
</table>
6. Network of interactions

Social network theory (e.g. (Bodin et al., 2005; Ernstson et al., 2008)) was used early in the project to assess the network of interactions among different groups. The aim of the exercise was to ensure that the network of interactions could provide for successful collaboration and information dissemination among the overall research team. This was motivated by the fact that, while the team, as a whole, may have all the information needed for the overall project, ensuring that this information reaches the specific researcher or manager who needs it is much less straightforward. Interviews were carried out with 44 individuals from government and non-government organisations having distinct ongoing roles in the project. Participants were asked to draw an egonet (or egocentric map (Marsden, 1990; Wasserman et al., 1995)) of the parties they interacted with and the perceived relationship between them. This provided a provisional map of a) where critical positive interactions occurred, b) where disruptive feedback loops or structural holes may be and c) which are the key nodes for the transmission and interpretation of particular forms information (Reagans et al., 2001).

A full description of the reconstructed social network can be found in (Dzidic et al., 2010). It highlighted weak inter-group connections, that is weak links between research, management, industry and local stakeholders as well as between different research teams. While connections within individual groups appeared to be quite strong, the disruption of a few inter-group links may have resulted in isolating an entire group with consequent large impact on the overall project connectivity and organic management.

In order to check how the interactions actually developed during the project, the exercise was repeated after project conclusion. 36 researchers replied to an online survey, specifying which interaction was included in their project plan and which was initiated and eventuated outside the project plan. The egonet resulting from this online survey is found in Figure 5. Here, the interactions included in the researchers’ project plan are described via dashed links, while the unplanned ones by thick links. A number of features can be noticed. First, according to the project plan, the interaction at the researcher level (dashed black lines in Figure 5) is much denser that the one at project management level, as described above. It is likely that this would have ensured a certain level of information exchange among researchers, even in the case that some management link had been disrupted, effectively making the researchers’ network more resilient than hypothesised in (Dzidic et al., 2010). Second, the actual interactions at the researcher level (dashed plus thick links in Figure 5) is even denser than planned, which suggests that much initiative was undertaken by researchers to initiate new interactions and new research projects when opportunities and gaps emerged. Naturally, this also implies that a certain level of flexibility was allowed in order for this to occur. This adds to the interaction between stakeholders and researchers, which also occurred to a larger extent than originally planned, as discussed in Section 4 and summarised in Figure 4, which also relied on considerable flexibility and improvisation.
7. Model development

The original project plan envisaged that the MSE would be based on the model InVitro (ref), a large mixed agent-based and continuous equation model previously used for a MSE project in a nearby region (Gray et al., 2006). The plan also required a considerable level of model re-engineering, plus re-parameterisation in order to port it to the Ningaloo region.

While the engagement actions in Figure 4 resemble a continuous, two-way process as in Figure 3 more closely than a sequential process as in Figure 2, the re-development of a large full-system model like InVitro, requires a software engineering team, whose workflow resembles Figure 2 much more closely than Figure 3. Clearly a certain level of flexibility is required by model developers, modellers and engagement team alike, in order to ensure that the model development progresses smoothly according to software engineering requirement, while the engagement both adapts to the stakeholders needs and informs the final model design.

As discussed in Section Error! Reference source not found., it also soon became clear that a model was needed in order to facilitate stakeholder interactions. InVitro was not expected to be ready in time for the engagement process to initiate. Furthermore, InVitro’s size and complexity did not make it suitable to a stakeholder group which included some members with little to no model experience. To circumvent this problem, the modelling team also designed or used a number of models of smaller size and scope specifically suited to the engagement stages discussed in Section 4. These include conceptual models, toy-models,
single-system models, and shuttle-models. In conceptual models the main drivers of a system are highlighted for subsequent representation as components of the full-system model; this usually results in a diagram summarising our understanding of how the system works. In toy-models a problem is simplified in such a way that only a handful of components are included. The purpose of these models is mostly educational. We want to understand how each component affects the problem and in order to achieve this, we temporarily renounce a satisfactory understanding of the overall problem. In single-system models we include a fairly detailed representation of a single component of the system (in our case recreational fishing and tourism). These models can be used to introduce stakeholders to modelling, provide temporary results from the study of a single activity, which will feed into the development of the final full-system model, or address sector-specific issues. In shuttle-models, we include the minimum number of processes we believe are crucial for a basic understanding of the overall problem. We know these models are still too simple for a full system description, but they provide a sufficient understanding to enable us to contemplate, build and use the more complex models needed for full problem description. The term ‘shuttle’ refers to taking us from a minimum to a full description of the problem, a journey which is necessary both to developers in model definition and parameterisation and to stakeholders in the interpretation of the final full-system model results. The details of each model used in this project are discussed in (Fulton et al., 2011).

The rationale for the use of such a diverse batch of models lies in our belief that in the MSE framework, a large section of the stakeholder group should interact with modelling: technical staff in public or private organisations may become model users by inheriting the model from scientists; some decision makers will interpret model results to formulate and implement policies; and the community will hopefully support and follow polices if they understand how and why they were developed. It is reasonable to believe that familiarisation with the models will benefit all these parties and make it more likely that MSE makes an impact. For this to be possible modellers need to provide a certain level of education in modelling philosophy and process. A computer program simulating an individual stakeholder’s everyday environment and daily actions can be received with a certain level of healthy scepticism, which needs to be overcome (‘how can a model account for the complexity of daily life?’, ‘how can a model prediction be believed, when the future is so uncertain?’). It is the modeller’s responsibility to explain why we model, how we do it, how uncertainty is addressed and to what extent the model results are informative.

We carried out this task via four types of activities: a) seminars and public presentations, b) conceptual model building, c) modelling showcases and d) modelling workshops. Our experience is that some activities need repeating for successful reception. We have collected anecdotal evidence of ‘flashes of understanding’ occurring suddenly at the 3rd or 4th presentation as a result of a slightly different communication styles.

8. **Scenario development**

The final aim of the MSE is to assess what futures are desired and possible, and to evaluate their likely trade-offs. These futures represent the ‘questions’ we ask the model and the ‘answers’ the model provides give us some indication of the likely trade-offs. Formulating these questions is not easy. A stakeholders group as diverse as the one related to the Ningaloo region can naturally produce a very diverse range of desired futures and opinions on what is acceptable. Also, only a limited number of questions can be asked to complex models for the computation, analysis and communication of the results to be manageable.

Here we focus on an unexpected further difficulty we encountered: the lack of familiarity with modelling (both in term of philosophy and practise) made it difficult for some stakeholder groups to formulate the questions. In other words, certain stakeholders struggled
to define the scenarios for the model to run. This resulted in paralysis or in asking questions either too general or too specific. Modellers found this issue perplexing and at times frustrating, because of its impact on the project workflow. This is a very practical example of how different backgrounds, assumptions and knowledge can affect communication and it highlights the importance of stakeholder engagement.

To some modellers it appeared that the model was supposed not only to provide answers, but also to formulate questions, which is logically impossible from a modelling perspective (Boschetti et al., 2008b). However, it is indeed what is supposed to happen from an engagement perspective, if we accept that modelling is not what expert outsiders do, but rather a process that includes experts, stakeholders and the local community. Indeed, a combination of repeated modelling seminars, workshops, showcases and one-to-one meetings eventually did deliver the scenarios for the full-system model. It is important to notice that, while some workshops were organised specifically to design scenarios, the final scenarios were ultimately developed via a more complex and ad-hoc process, involving phone calls and e-mails, as well as workshops designed for different purposes. This is a further example that engagement goals and actions do not necessary coincide precisely.

In summary, stakeholder engagement impacted the model development in three ways. First, it inspired the implementation and use of a set of ‘small’ models (conceptual, toy, single-component and shuttle-models). Second, it defined the questions the models needed to answer, sharpening the focus from broad regional queries to questions about specific development issues of local concerns. Third, it influenced the structure and parameterisation of the full-system InVitro model, taking it from a simplified form of a version inherited from a previous project to its final implementation. The technical details of this transformation are beyond the scope of this work, but a rough appreciation can be obtained visually by comparing the model structures at different stages through the project, as summarised in #

1. Conceptual Model
2. Pilbara InVitro model structure used as an implementation starting point
3. Ecological components (after biological advice)
4. Tourism relevant components (after expert and local advice)
5. Initial full system model (focusing on direct connections)
6. Final full system model form

Figure 6.
1. Conceptual Model

2. Pilbara InVitro model structure used as an implementation starting point

3. Ecological components (after biological advice)

4. Tourism relevant components (after expert and local advice)

5. Initial full system model (focusing on direct connections)

6. Final full system model form

Figure 6. InVitro model structure at different stage through the project.
9. Discussion

Other research into the engagement process (Chapman et al., 2011) characterises the Ningaloo coast as a turbulent socio-political environment due to the constant staff turnover, the dynamic nature of tourism and the growing resource sector industry. The adaptive response of researchers to engagement and their willingness to repeat engagement processes was necessary in this environment in order to elicit emergent behavioural responses, and then reinforce them through responding to requests for information or modelling results. In turn, the emergence of new behaviour amongst stakeholders elicited the adaptive modelling processes described here. While this is a positive and necessary development, further steps could be taken in future projects to initiate, foster and reinforce similar processes in stakeholder-modeller interactions. In particular, the presence of locals on research management committees, a focus on and readiness to take advantage of local issues as soon as they arise as a research management priority, and local engagement at the early stages of formulating communications plans and strategies would further enhance the impact of a modelling project (Chapman et al., 2011).

Of course, the numbers of people, level of interaction, and amount of information exchanged are likely to lead to chains of events going far beyond the impacts discussed in this paper. Here we purposely limited our analysis to impacts which could be assessed, in a semi-objective fashion, by comparing a project plan against an actual project development. The definition of impact we propose in Section 3 involves identifying specific events (stakeholder engagement initiatives in our case) and evaluating their consequences against the counterfactual guess of what would have happened in their absence.

In principle, the same approach could be employed to establish the longer-term impact of a project. What is needed is a) a prediction of how we expect a system (the Ningaloo Region in our case) would have developed in the absence of the MSE project, b) the actual future development and c) a reasonable assessment of what actual events are more strongly related to the project outcome.

As we mentioned above, the further ahead we look into the future, the less reliable such approach will inevitably be. Nevertheless, it may still be worth carrying out. At the core of involving stakeholders in designing a MSE process there is the intent to predict, prepare for and, as far as possible, steer the future. Mankind has tried to do this since the beginning of time, with efforts becoming more rigorous, formal, frequent and larger since the 1950s (Bezold; Bootz; Coates et al.; Durance; Ringland). Unfortunately, much less effort is put into evaluating these projects: which one predicted better? Which ones better steered the future according to the stakeholders’ intent? Under what conditions did they work or fail? An effort pertaining to the future needs waiting for the future in order to evaluate; not carrying out this evaluation is like performing a lab experiment without bothering to check the results. Knowing what worked and what failed in a specific project will be of immense value to the next one.

In the short to medium-term all parties will likely monitor project outcomes somehow: decision makers and project initiators have an administrative pressure to justify the work; scientists need to demonstrate their relevance outside academia; local stakeholders’ effort in trusting and collaborating with the process will be vindicated by seeing practical outcomes. But there is also a longer-term purpose in monitoring project impacts and the proposed approach may provide a framework for such effort.
10. Conclusions

Looking back at an MSE project after completion and comparing it against the original project plan, we detect a number of examples of how the project evolved in unexpected ways, adapting to circumstances as they occurred. Most of these changes can be attributed to different aspects of stakeholder engagement. First, the project plan itself and the researchers’ effort changed considerably: 43% of the total research time was dedicated solely to stakeholder engagement. Second, the researchers’ network is much tighter than the project plan envisaged. Many more collaborations and much more information exchange have occurred, which in turns may lead to serendipitous future developments. Third, the computer model at the core of the MSE looks very different from its original design as a result of both information collected and the requirement to address issues of specific local interest. Fourth, the stakeholder engagement process triggered a number of novel behaviours among some groups and organisations in the Ningaloo region, as local individuals and groups took more interest in using the modelling research for decision-making, and began to organise in ways that facilitated the transfer of modelling knowledge and capacity (Chapman et al. 2011). We have reason to believe that, at least among some stakeholder groups, model acceptance and the general understanding on how the region functions at a socio-ecological level has improved. In-progress research due for completion in 2011 will provide a qualitative evaluation of how stakeholders’ knowledge, behaviours and networks have changed as a result of the engagement process. Fifth, researchers have a much deeper understanding of who the stakeholders are, of their concerns and how best to communicate with them. Finally, the overall view of what a MSE project involves has matured within the research team.

This interaction and learning depends on the good will, open minds, dedication and enthusiasm on all parties, which we optimistically like to believe are most often available. Crucially however, it also depends on allowance for flexibility: on being able to change project schedule, move effort allocation and act on opportunities as they occur. In other words, allowing the MSE project to be as adaptive as the adaptive management it aims to simulate. This allowance may not always be present, especially when the MSE project involves the development of a complex piece of software engineering. We suggest that project planning will need to carefully account for all these factors in order to be successful.

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APPENDIX 9

NRP REGIONAL REFERENCE GROUP TERMS OF REFERENCE (DRAFT)
Ningaloo Research Regional Group

Terms of Reference (DRAFT)

The Ningaloo Research Program has been conducting research in the Ningaloo Region since 2005. This $36 million program is scheduled for completion in 2010/11. A vital step in the project is transferring the key research findings to the people of Ningaloo. The Ningaloo Research Regional Reference Group has been established to provide advice, assistance and a communication pathway for this process.

Background

The Ningaloo Reef is Australia’s largest fringing coral reef, extending across 300 km of coastline between Exmouth and Carnarvon. This spectacular area is a global biodiversity hotspot and a premier tourist destination, seeing as many as 200,000 visitors each year. Balancing the conservation of this unique marine ecosystem with sustainable development of the region is a major challenge. A range of organisations are working together through the Western Australian Marine Science Institution (WAMSI), CSIRO’s Ningaloo Collaboration Cluster and the Australian Institute of Marine Science to help meet this challenge. This partnership, the Ningaloo Research Partnership (NRP), brings together scientists and expertise from a range of disciplines with the aim of integrating knowledge of reef use, biodiversity and socio-economics into managing the Ningaloo region. Organisations contributing to the NRP through WAMSI and the CSIRO Cluster are:

- the WA Department of Environment & Conservation
- the Australian Institute of Marine Science
- Murdoch University
- the Australian National University
- Curtin University of Technology
- Edith Cowan University
- the University of Queensland
- the University of Western Australia
- the Sustainable Tourism Cooperative Research Centre
- CSIRO.

The NRP is scheduled for staged completion by mid-2011. Most of the scientists are now writing up their research results. The next step is transferring the key research findings to the people who live, work and play in the Ningaloo region.

Purpose of the Regional Reference Group

Communicating research results to the people, groups and agencies of the Ningaloo Region (Carnarvon to Exmouth) is integral to the success of our research. The purpose of this group is to provide advice, assistance and a communication pathway (where appropriate) to the NRP in transferring these results to the region. It will also provide information to the NRP on the needs for knowledge, science and planning in the region and issues that the region is facing.

Roles

1. Liaise with the NRP communication sub-committee to review and provide advice on NRP communications within the region
2. Assist the NRP with the roll-out of its regional communications strategy.
3. Liaise with NRP coordinators to provide advice on stakeholder engagement in the region
4. To assist the NRP with the roll-out of stakeholder engagement in the region.
5. To facilitate the establishment of a regional research coordinator position.

These roles will be reviewed and revised by the reference group in December 2010 and the results of the review will be discussed with the Ningaloo Research Coordination Committee at this time.

Note that the Coral Coast Parks Advisory Committee is the official advisory group for DEC in the region, and this group will be reconstituted shortly.

Composition of the Regional Reference Group

Chair: TBD
Executive Officer: Ningaloo Regional Research Coordinator (TBD)
Members:
Membership is encouraged from all sectors and individuals in the region possessing a genuine interest in knowledge transfer between the Ningaloo research partners and the local region.
- Karen Thompson, Exmouth GDC
- Kim Whitehall-Hoia, Carnarvon GDC
- Ronnie Fleay, Ningaloo Research Centre, Shire of Exmouth
- TBD, Shire of Carnarvon
- TBD, Coral Bay Progress Association
- Barry Sullivan, Exmouth Chamber of Commerce
- Jackie Tapper, Exmouth Visitor Centre Marketing Committee
- Chris Pain, Exmouth Visitor Centre
- Jamie Campbell, DEC Exmouth District (TBD)
- Susie Bedford, Exmouth High School, CCG
- Ann Preet, Northwest Cape Aboriginal Corp (TBD)
- Paul Baron, Bardiya Aboriginal Corporation (TBD)
- Leonie McLeod, Wnarra Station (TBD)
- Phil Kendrick, Ningaloo Station (TBD)
- Paul Richardson/Karen Hattingh, Gnaraloo Station (TBD)
- Tim Meecham, Quobba Station (TBD)
Meetings

The Reference Group will meet monthly or as required. The Chair (or selected representative) of the Reference Group will attend monthly meetings of Ningaloo Cluster Management Committee (by phone), and occasional meetings of the Ningaloo Research Coordinating Committee. The Regional Reference Group and the Ningaloo Cluster Management Committee will endeavour to have one or two face-to-face meetings per year.
APPENDIX 10

MODELLING WORKSHOP EVALUATION AND QUESTIONNAIRE RESULTS
Actors and Models: Assessment of the Ningaloo Modelling Workshops
(Prepared by Tod Jones)

Background (projects and past engagement, description of the models):

The Ningaloo models are a suite of different simulation tools that were developed as part of the Ningaloo Collaboration Cluster group of projects within the CSIRO's Wealth from Ocean’s Flagship (information on the Ningaloo Research Program and the Ningaloo Collaboration Cluster is available from www.ningaloo.org). The research projects that developed the Ningaloo models began in 2007 and the models were completed in 2011.

Conversations, discussions and forums were a crucial element of developing the models. 13 forums in total were held in the Ningaloo Coast region (in Carnarvon, Exmouth and Coral Bay) and in Perth where ideas and conversation defined the characteristics of the models, researchers presented modelling results, and participants provided feedback. The Ningaloo Modelling Workshops consist of four additional workshops that were held in October 2010 (Carnarvon and Exmouth) and March 2011 (Perth and Coral Bay) where participants from a variety of backgrounds received an introduction to adaptive management, then collaboratively used the models to meet different management objectives.

Three models were presented in the Ningaloo Modelling Workshops.

- The Ningaloo Tourism Destination Model is a numerical model that simulates different development strategies for the Ningaloo coastline, providing outputs across a range of indicators that are divided into economic, tourism, social and environmental.

- The Ningaloo Ecopath with Ecosim Model simulates the ecological impacts of different management scenarios, as well as the implications for different activities (such as catch rates for recreational or commercial fishing). The Ningaloo Ecopath with Ecosim Model was calibrated and one-way coupled with the Ningaloo Tourism Destination Model in order to simulate the ecological impacts of different tourism planning decisions.

- The Ningaloo In Vitro Model is a multi-platform model that simulates ecological and sector impacts of different management scenarios. This model and its interface was presented at the Workshops, but was not ready for live use.

The Workshops:

The workshops were well attended in Exmouth (8 participants) and Perth (18), but struggled for numbers in Carnarvon (2) and Coral Bay (3). Participants in Exmouth and Perth were from a variety of institutions including the Shire, DEC, Fisheries, an NGO (Exmouth) and Tourism WA, DEC, Department of Fisheries, Department of Lands and Regional Development, Department of Planning, Department of Transport, and the Environmental Protection Agency (all Western Australian). These two workshops incorporated people with a broad range of professional experience and agency orientations. Carnarvon attracted a participant from the GDC and another from the Shire. Participation was limited by three separate events that removed three key participants in the week of the training. Coral Bay numbers were down primarily due to flooding that created additional work on the stations, cut communication lines and closed road access to most of the stations.

The workshops all followed the same format, although the Perth workshop was shortened to one day at the request of participants, while the regional workshops in Carnarvon and Exmouth ran for two days. The structure of the format was:

- Introduction to and training in adaptive management.
- Overview of Ningaloo In Vitro Model and its interface.
- Training in using the Ningaloo Tourism Destination Model.
- Training in using the Ningaloo Ecopath with Ecosim Model (optional in Perth at the choice of participants, as the people primarily interested in it were from DEC who were to
be directly supported by Hector Lozano-Montes who spent 2 months sitting at DEC to help with the uptake of the models).

- Collaborative use of the models to achieve management objectives (set by the facilitator).
- Discussion of the models and providing written feedback.

Evaluation:

Evaluation took place through both discussion and written feedback. The discussions allowed for open-ended discussion including positive comments and criticism of the modelling interfaces, such as the request from different agencies for time frames that fit their planning cycles. Here we focus on participant’s experiences of the workshop and its effectiveness as a collaborative learning forum. The open discussion evoked broadly positive comments regarding what the participants had learnt through the workshops from using the models. There was evidence that using the models enabled participants to connect management decisions and impacts in new ways and began to consider them part of the same system. In Exmouth, a senior Shire staff member said that “Never ever until today, have I thought about how planning effects what happens in the water.” Another participant in Exmouth stated that he now was asking what “type of tourism” would be good for Exmouth, rather than “tourism per se”.

The written feedback indicated that participants became more familiar and confident with adaptive management through the modelling workshops. When asked directly about the impact of the workshop on their understanding of Adaptive Management in the written feedback, 14 participants indicated they were more confident, four wrote no change, five wrote ambiguous answers, and three left the written feedback blank. While this indicates the ambiguity of both feedback and workshops and the need for further refinement, it also indicates that at least over half the participants improved their understanding of adaptive management through their involvement. A related response was that five participants also commented in the verbal and written feedback on the need for immediate action to begin to address problems, and the difficulty of reversing decline in recreational fishing stocks if tourism continues to grow.

An important outcome was promotion of the models and an understanding of what they can do. This was consistently identified as the most important outcome in the written feedback, which also indicated participants’ appreciation of the opportunity to learn about and use professional management tools.

Participants identified a variety of uses for the model in their institution, including statutory planning for the Department of Environment and Conservation, and for environmental impact assessment in the case of the EPA. A representative of Regional Development and Lands made the comment that although his Department did not do strategic planning, now he knew about the models he would expect any plans that needed to be approved by his department to include assessment of modelling results and impacts or the submissions would “almost be negligent”. Three participants requested more explicit information about the assumptions of the model. Many of the assumptions were included in the interface, but time constraints limited the capacity to cover all of this information in the workshop. However, participants could explore these through investigating the model themselves, or reading online documentation (links were provided in the model).

Finally, written feedback indicated that participants enjoyed the workshops. Due to minor tweaks and changes across the workshops, comments about difficulties using the models reduced in number and intensity. Just over half of the 31 participants explicitly wrote that the workshop was a positive experience in the “any additional comments” section of the written feedback.

Lessons learnt:

- Well-run modelling workshops familiarise people with research projects and the tools that they produce, which is greatly appreciated by participants.
- Modelling workshops increase managers’ awareness of the urgency of intervention and the long-term implications of different types of intervention.
- Incorporating an initial introduction to adaptive management session is an important way of framing the models to ensure that they are not viewed as the ‘magic bullet’ to problems, but a way of learning about the implications of different management decisions. There is also evidence that this increases participants’ confidence in dealing with adaptive management. Any future workshops should continue to refine the integration of Adaptive Management into the workshop format.

- Small groups are important in helping people who do not pick up new technologies quickly use and interpret the models. Discussions that happen in these small groups are crucial to learning.

- After providing an overview of how to use the model, use a clear but detailed instruction sheet for each of the small groups with an extensive simulation to assist familiarisation with the interface.

- Need for presenters to be adaptive and engaged, continuously engaging with participants to answer questions, clarify results and introduce new challenges if participants become comfortable or disengaged. The rate of introduction of new scenarios needs to be tailored to the speed of the workshop participants.

**What’s next?**

Engagement with the modelling tools is continuing through the work of Hector Lozano, who is currently based in DEC, Kensington. Hector has presented the models to the broader DEC membership than was possible at the training workshops. In response he has had numerous requests to run scenarios and refine or update the models based on new data made available by DEC researchers. This “in house” liaison position has worked remarkably well for initial uptake – though obviously it needs to be seen if this can continue once Hector is not on site. Nevertheless, the researchers have indicated their willingness to facilitate use of the models to assess management plans and decisions, and we are confident in saying that all of the key agencies and groups active during the time of the projects were contacted and that the models were actively promoted in Perth and the Ningaloo Coast region.

As the Ningaloo Collaboration Cluster is now coming towards completion and many of the projects are no longer receiving funding, use of the models will become determined by requests from different bodies and agencies. The researchers are happy to present the models or run the workshops for individual agencies.
Adaptive Management & Modelling – Oct 2010
TRAINING EVALUATION

How are we doing?

To what degree did the workshop increase my understanding of management strategy evaluation?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Slightly</th>
<th>Somewhat (3)</th>
<th>A great deal (2)</th>
</tr>
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</table>

- Wasn’t present
- Already had info on this

Comment/suggestions?

To what degree did the workshop increase my understanding of adaptive management?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Slightly</th>
<th>Somewhat (3)</th>
<th>A great deal (3)</th>
</tr>
</thead>
</table>

Comment/suggestions?

To what degree did the workshop increase my understanding of how to use the Ningaloo Tourism Destination Model?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Slightly</th>
<th>Somewhat (1)</th>
<th>A great deal (5)</th>
</tr>
</thead>
</table>

- Will be great once I have less guesswork based data – plus I need a lot of practice!
- Already understood what it was but using it helped

Comment/suggestions?

To what degree did the workshop increase my understanding of how to use the Ningaloo Atlas?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Slightly (2)</th>
<th>Somewhat (3)</th>
<th>A great deal (1)</th>
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</table>

Comment/suggestions?

To what degree did the workshop increase my understanding of how to use the Ningaloo Ecosim Model?

<table>
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<tr>
<th>Not at all</th>
<th>Slightly (1)</th>
<th>Somewhat (1.5)</th>
<th>A great deal (3.5)</th>
</tr>
</thead>
</table>

- Conversion from Destination model to Ecosim model got too technical for me.
- Very complex, would need a lot of practice.

Comment/suggestions?
As a result of this session I feel adaptive management and modelling can help address some of my interests or concerns in the Ningaloo region.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>(3)</th>
<th>Strongly Agree</th>
</tr>
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<tr>
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</tbody>
</table>

* Could be a theoretical tool for major planning developments presented to Council

**Comment/suggestions?**

As a result of this session I intend to do the following:

* Consider implementing program within council operations
* Play with the EcoSim model
* This is the one question I was left with after 2 days; still don’t know and would have been great if we would have been able to define a “group/shared Action”

**Where could this workshop be improved?**

* No suggestions
* User-friendliness of models
* If there was more time, discussion could have been held on what the model/scenario outcomes mean for Region/Exmouth. The last discussion we had for 30 minutes was really useful and the above question “What am we going to do” should have been asked.

**What were the strengths/benefits of the workshop?**

* Well presented Aimed at technical staff but still gave an overview to management.
* Really got a diverse group of people talking
* Clear presentations
* Playing around with model to gain understanding
* Sharing ideas with other organizations.
Research Uptake in Western Australia’s Ningaloo Region: Evaluation of knowledge transfer process

Stakeholder Interview Results

Compiled by Kelly Chapman
September 2012

IMPORTANT NOTE:
The comments in this document are the recorded opinions of those interviewed and do not necessarily represent fact or reflect the positions of any particular agencies, organisations or sectors
Executive Summary

1 Introduction

The Ningaloo Collaboration Cluster (NCC) has brought together scientists from a range of disciplines with the goal of describing, understanding and modelling the processes of human interaction with Ningaloo Reef. The ultimate aim of this research is to provide managers with knowledge and tools for making well-informed decisions about the Ningaloo Marine Park and the region (findings to date can be accessed at www.ningaloo.org.au).

The uptake of sustainable management options – moving from research to practice – however, depends on the adaptive capacity of the institutions responsible for managing resources and tourism in the Ningaloo area. Adaptive capacity in this case can be defined as the ability and willingness of institutions to learn from and use NCC’s data and modelling results in a way that leads to more sustainable management decisions (both socially and ecologically) in the Ningaloo region.

However, research from around the world shows that attempts to improve research uptake by management often fall short, despite growing recognition that sustainable environmental management requires the ongoing integration of new and relevant knowledge.

I am a PhD student exploring this issue in Ningaloo. The objective of my study is to examine the nature and effect of knowledge transfer between researchers and stakeholders in the NCC and in the Ningaloo region (between 2009 and 2011), particularly in relation to the organisational learning, knowledge management, and complexity literature. Specifically, we aim to answer the following research questions:

1. What are the critical success and failure factors associated with building adaptive, institutions, as commonly identified in the environmental management literature?
2. What were the barriers to and opportunities for knowledge transfer in the Ningaloo region as perceived by stakeholders and researchers?
3. How can the social sciences and complexity theory contribute to our understanding of knowledge transfer in environmental management?
4. What knowledge transfer processes emerged through the course of the study, and how did they affect the knowledge, perspectives, behaviours and relationships of various stakeholders and researchers?
5. How effective was the knowledge transfer process from a stakeholder/researcher perspective?
6. How can these results contribute to a framework for building adaptive institutions?

Between August 2009 and August 2010 I conducted over 30 interviews with researchers, government staff, business owners, tourism operators, pastoralists and community members, to explore their ideas around barriers and opportunities for translating NRP’s research into practice. The results of those interviews are compiled in the document titled: Research Uptake in Western Australia’s Ningaloo Region: Barriers & Opportunities (2010), which was shared with all those who participated in interviews.

Between 2010 and 2011, the Ningaloo Collaboration Cluster undertook numerous knowledge transfer activities in the Ningaloo region, particularly with respect to the computer models that were built from research conducted

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1 The Ningaloo Collaboration Cluster is a major research project that commenced in the region in 2007, involving researchers from the CSIRO, Sustainable Tourism Cooperative Research Centre and a range of Australian Universities including Curtin University of Technology, Murdoch University, University of Western Australia, Australian National University and the University of Queensland.
in the region, namely the Ningaloo Destination Model (Jones et al. 2011), and the Management Strategy Evaluation (MSE) modelling (Fulton et al. 2011). These activities included the Ningaloo Symposium, numerous meetings and presentations with various local agencies, groups, and station owners, modelling training workshops and public presentations.

Between July and October 2011, I conducted a final round of evaluation interviews with a subset of eight stakeholders representing different regional interests and research interests in the Ningaloo area, including scientists involved in the knowledge transfer activities. The purpose of these interviews was to evaluate if and how a cross-section of stakeholders (including scientists) have been affected by the knowledge transfer process, and reveal the different forms of knowledge that were generated in the process, with a specific focus on changes in:

1. what stakeholders know (knowledge as an object)
2. how stakeholders are doing things (knowledge as action)
3. relationships between stakeholders (knowledge as a process of relating)
4. stakeholder perspectives (knowledge as reflection)

How these types of knowledge were generated and how they are related will be explored in my doctoral thesis. In addition, the evaluation interviews will be used to gather stakeholder insights on what did and didn’t work in the knowledge transfer process, and suggestions for improvements and next steps. These results, together with those generated from the first round of stakeholder interviews, will be examined in the context of complexity theory and the social science literature in my thesis.

PLEASE NOTE, the comments in this document are the recorded opinions of those interviewed and do not necessarily represent fact or reflect the positions of any particular agencies, organisations or sectors.

2 Summary of Interview Results – types of knowledge generated

This data was compiled from interviews conducted with stakeholders between July and October 2011. In this summary the results from the scientists are distinguished from those of locally-based stakeholders.

2.1 Do you know anything now that you didn’t before?

No or not sure
When first asked this question, half of the eight interviewees were unable to answer right away, either saying no or they were not sure, despite all having been primary targets for knowledge transfer by the Ningaloo research program.

Environment, economy & community
Some of the locally-based stakeholders noted that they had learned more about the general environment, tourism, oil and gas, and the community itself. They also indicated that they are more aware of the research program and the models that have been produced.

System sensitivity & drivers
One of the scientists indicated that they had learned a number of things from running their models. For example the models showed that there is a large conflict between marine environment and the social well-being of the community, in that Exmouth needs more economic stimulus, and the marine environment is more fragile and unpredictable than expected.
The scientists also indicated that they had learned things through the stakeholder engagement process, including what some of the biggest pressures/drivers on Ningaloo system are (e.g. facilities and access).

**Importance of communication & engagement**
The scientists indicated that they had learned about the importance (and difficulty) of meaningful communication and stakeholder engagement to the success of research and modeling projects.

### 2.2 Are you doing anything differently?

**No**
Only one interviewee indicated that they were not doing anything differently as a result of the knowledge transfer process.

**Different approach to research**
Some of the scientists indicated that they had made changes in how they approach modeling and research (e.g. being more flexible and adaptive), changed how they communicate science, and increased their focus on stakeholder engagement.

**Spin-off projects**
The scientists also indicated that engagement with regional stakeholders had resulted in some spin-off projects, including an application to fund research staff at the proposed Ningaloo Research Centre.

**Improved networking and communication**
Locally based stakeholders highlighted that the knowledge transfer process had resulted in improved networks and communications between stakeholder groups, more openness between groups, breaking down of silos, and greater contact with researchers. There was also mention of becoming more involved with conservation and the community. When asked if they had shared anything learned with others, most of the stakeholders indicated that they had shared some information with their immediate circles.

**Model use**
There were mixed opinions about whether the models would be used by local agencies for planning. Some comments indicated they were too complicated, another interviewee suggested they would like to use them but wasn’t sure, and another indicated they were quite keen to use the models.

**Governance**
Other outcomes in relation to local governance included application for an Shire environmental officer, and stated intentions by local agencies to increase their focus on community consultation. One interviewee also expressed an intention to practice more adaptive management.

### 2.3 Do you associate with anyone new or differently?

**No, limited**
A couple of the interviewees indicated that they weren’t really associating with anyone new as a result of the knowledge transfer process, however, as the conversation progressed indicated that they had developed some new relationships.

**Yes**
Locally based stakeholders indicated that they had developed relationships with some researchers, notably Tod and Beth, and with other groups in the regions. Notably, a number of interviewees stated that relationships between local agencies and groups had improved as a result of the process. The scientists indicated that they had developed new relationships with other researchers, and with people from the local community and local agencies.
Nature of new/changed relationships
When asked to describe the nature of their new relationships, common themes included informal and friendly, and professional and friendly. Candidness, respectfulness, trust, inclusiveness and willingness to share were also mentioned. One interviewee noticed that as a result of their outward support for World Heritage their relationships with some people in the community had changed in a negative way.

2.4 Has your thinking or perspective changed on anything?

No, not much
One interviewee stated that their perspective had not changed as a result of the knowledge transfer process, except in relation to what they learned at the Ningaloo Symposium. Another stated that although they couldn’t cite specific figures as a result of the knowledge transfer process, they did feel they had more insight and awareness generally. Another stated that the process had strengthened their existing beliefs.

New ways of communicating
Other locally based stakeholders stated that the process had opened their eyes to new ways of communicating with different groups, and the idea that getting information out to the community could be a responsibility shared between different groups and agencies.

Openness to new ideas and practices
Some locally based stakeholders also indicated that they were more open to environmental concerns, and more aware of the implications of their actions. Comments were also made about thinking more about change and the future, the importance of World Heritage, and the effects of the tourism cycle. Another noted that the theme of adaptive management had really come through, and the need for using it in their day-to-day practice.

Role of science
The scientists interviewed indicated that the process had changed their perspectives on the role of the science (that it needs to take a more active role), and that greater investment needs to be put into interpreting science. They noted that they now recognize the need for adaptive/flexible approaches to modeling, that focus on what people need and want, and that value and incorporate anecdotal and local information.

Community perspectives
With respect to changes in how others think, local interviewees indicated that they believed the process had helped community members be more aware of the research that’s taken place. Those that had been targeted specifically for intensive training were perceived to be more open-minded about the models. However, it was also noted that there is still a barrier between scientists and the community, and that the general community was still quite skeptical of some of the information generated by research.

3 Summary of Interview Results – stakeholder evaluation of knowledge transfer process

3.1 What are your overall thoughts on how the process went?

Communicating research results
A number of the interviewees indicated they appreciated the effort that was made to transfer knowledge, particularly relative to the effort made by previous projects, but that they weren’t sure how well it worked or how big an impact it had made.

Locally-based stakeholders largely indicated that they hadn’t really looked at the NRP and Ningaloo Atlas websites, and those that did thought the available information was limited. There was positive feedback
regarding community presentations, the Whale Shark Festival, and the Ningaloo Symposium. Concern was expressed about making sure research results are conveyed to private interests as well as government agencies. Concern was also expressed about the availability of concrete information, delays in seeing final research results, providing reasonable access to the research results, and leaving something behind for the community. The importance of the proposed Ningaloo Research Centre in communicating research results was also mentioned, as was the World Heritage Committee, once its formed. The importance of personal contact, the community notice board, informal get-togethers and the building relationships between researchers and community members were also noted.

A mention was also made that one public research presentation presented results that were very different to local people’s estimation of the situation. This had the effect of making them skeptical about other research that was presented.

Models

It was suggested that although the model training was a good effort, ultimately the model is too complicated for non-specialists to use, and that the biggest value of the training was the bringing together of different groups. One of scientists indicated that six months after the training, they still had not received a request from anyone to use their model. It was likewise noted that despite a positive reception by agencies in Perth, no follow-up requests had yet been received. On the positive side, it was noted that applications have been submitted for projects that will use the models if funded.

One locally-based interviewee felt using real local projects for the model training would have had more impact and created more local ownership and initiative for their continued use. Another locally based stakeholder indicated that they felt the models would be used by the Shire for proactive planning and managing growth. The importance of finding a custodian for the models with the closing of the NSDO was noted, as well as the need for keeping the models up to date.

Other suggestions included using a smaller stakeholder group, using simpler models, and educating stakeholders about using models in phases, in the context of complex systems and adaptive management.

Managing the Research Program

Suggestions made for improving research uptake also included: having regional people sit on the research management committee, basing someone in the region, and providing resources for integrating research with events and activities in the region.

Engaging Locals

Some of the interviewees made comments about the first round of compiled stakeholder interviews, noting that the interview results helped them understand the perspectives of other groups. One interviewee noted that they felt stakeholder communications were excellent particularly with Beth and Tod. On the other hand, another interviewee felt there was very little return for engaging with researchers, and was still waiting to receive promised copies of final reports.

Most of the suggestions related to engaging stakeholders earlier in the process. Recommendations included creating ‘tribe’ at the beginning of the research program, involving locals in research from the start, hosting scientists in the community (rather than hotels etc.), more informal contact between researchers and locals, identifying community leaders/champions, and creating personal relationships/standing in the community.

It was also noted that the knowledge transfer process was assisted by the imperative created by recently proposed developments, and by the fresh slate created by changes in the heads of most of the Exmouth-based agencies.

Reference Group

One of the stakeholders believed the reference group had little impact, and another felt it didn’t work in practice, that it was all talk and no action, and a bad use of commercial time. Others felt that the group had considerable
value, particularly in terms of networking between groups and bringing people together in face-to-face communication. It was commented that the group had been an important forum for informal discussion between agencies, one which didn’t otherwise exist in the community, and that it helped dissolve some of the distrust between local organisations.

It was also noted that it would have been more appropriate if the group was run by a local agency, and coordinated by someone from within the community. Another noted that the group should have had a clear mandate, jurisdiction and funding before it commenced.

**Research Coordinator**
Views were mixed on the value of the research coordinator. Some locally based interviewees felt they didn’t see much result from the coordinator position, in terms of liaising with and getting information out to stakeholders. Others felt that the coordinator played an important role in presenting the program’s research at the whale shark festival and in developing grant applications for community monitoring etc. Concerns were also expressed about the long delay in releasing funding for the coordinator position, and lack of planning and resourcing for the position and the reference group.

**Adaptive Approach**
One of the scientists noted that it had been a very adaptive process, and that this would likely become a basis for how they do things in the future.

**Next Steps**
Suggestions for next steps included:

- Ongoing meetings between regional heads of agencies
- Presentations at Shire community information sessions
- Follow-up symposium in the region
- Highlighting knowledge transfer challenges in thesis
- Continue presenting information and engaging with community

**3.2 Can you see other applications for this process?**

Interviewees felt that a similar stakeholder engagement process could have a number of other applications including:

- Sustainable development projects, regionally and nationally
- World Heritage and parks planning
- Keeping the community up to date on agency activities
- The Ningaloo Research Centre
- Regional planning

**3.3 Thoughts on the knowledge brokering role (Kelly Chapman’s role)**

Interviewees made a number of comments about their thoughts on the role that was taken on by Kelly Chapman (as a ‘knowledge broker’).
Networking
Interviewees indicated Kelly’s activities were valuable in connecting community people and researchers, facilitating relationships, providing a point of contact, and connecting researchers with local concerns. It was also noted that Kelly played a role in drawing regional stakeholders together, and helping establish mutual understanding between groups. It was suggested that it’s important to have someone actively fostering these connections. Interviewees also noted that while contact had dropped off between stakeholders after Kelly left, relationships had persisted, although on a less formal, more irregular basis.

Communicating knowledge
There were some comments indicating interviewees had valued the time Kelly spent explaining the research, and that she had helped ‘open their eyes’ to what was happening in the region. Another noted that Kelly had helped researchers tap into local information networks when doing their promotions, etc.

Facilitating/driving
It was also noted that Kelly had played a role in driving action, influencing how meetings and presentations were run and information communicated, and generating interest and getting people to ask new questions for the models.

Providing regional input to research program
Some interviewees noted that Kelly helped ensure that regional input was considered in the CSIRO/NRP communication’s plan, in addition to providing regional context in the monthly research management committee meetings.

Issues with the role
Interviewees raised a number of issues that arose around Kelly’s activities in the region. These included poor handling of agency sensitivities, particularly around the formation of the reference group, stepping on some agency toes, and inadequate communication with agency’s headquarter staff in Perth. It was also noted that her operating without mandate created concern, and that there was some distrust among agencies as to her motives. It was also noted that action research, the basis of Kelly’s activities, is a foreign concept to biophysical scientists, so they didn’t understand why she was getting involved in the system she was researching.

Positive attributes
Positive attributes that interviewee’s felt Kelly brought to the knowledge brokering role included:

- Outgoing personality
- Knowledgeable
- Professional
- Neutral outsider
- Well connected and available
- Social science background
- Strong communication skills
- Willingness to share knowledge
- Relevant qualifications & skills
- Able to work with people
- Listening skills
- Caring about region
- Genuine
- Fitting in with locals

Negative attributes
Negative attributes that interviewee’s felt Kelly brought to the knowledge brokering role included:

- Lack of political sensitivity/bluntness
- Over-assertive as a PhD student
- Not a member of the community or employee of local agency
Acknowledgements

First and foremost, many thanks to the people who took time out of their busy schedules to meet with me and provide their valuable input for this document. Thanks also to CSIRO and ECU for funding this project, and to the Ningaloo Turtle Program and DEC Exmouth for providing me with office space. And finally, special thanks to all those who offered me places to stay, those who hosted me in their homes, on their properties and on their boats, and those who gave me encouragement, moral support and friendship along the way.
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Introduction

The Ningaloo Collaboration Cluster\(^2\) (NCC) has brought together scientists from a range of disciplines with the goal of describing, understanding and modelling the processes of human interaction with Ningaloo Reef. The ultimate aim of this research is to provide managers with knowledge and tools for making well informed decisions about the Ningaloo Marine Park and the region (findings to date can be accessed at www.ningaloo.org.au).

The uptake of sustainable management options – moving from research to practice – however, depends on the adaptive capacity of the institutions responsible for managing resources and tourism in the Ningaloo area. Adaptive capacity in this case can be defined as the ability and willingness of institutions to learn from and use NCC’s data and modelling results in a way that leads to more sustainable management decisions (both socially and ecologically) in the Ningaloo region.

However, research from around the world shows that attempts to improve research uptake by management often fall short, despite growing recognition that sustainable environmental management requires the ongoing integration of new and relevant knowledge.

I am a PhD student exploring this issue in Ningaloo. The objective of my study is to examine the nature and effect of knowledge transfer between researchers and stakeholders in the NCC and in the Ningaloo region (between 2009 and 2011), particularly in relation to the organisational learning, knowledge management, and complexity literature. Specifically, we aim to answer the following research questions:

1. What are the critical success and failure factors associated with building adaptive, institutions, as commonly identified in the environmental management literature?
2. What were the barriers to and opportunities for knowledge transfer in the Ningaloo region as perceived by stakeholders and researchers?
3. How can the social sciences and complexity theory contribute to our understanding of knowledge transfer in environmental management?
4. What knowledge transfer processes emerged through the course of the study, and how did they affect the knowledge, perspectives, behaviours and relationships of various stakeholders and researchers?
5. How effective was the knowledge transfer process from a stakeholder/researcher perspective?
6. How can these results contribute to a framework for building adaptive institutions?

Between August 2009 and August 2010 I conducted over 30 interviews with researchers, government staff, business owners, tourism operators, pastoralists and community members, to explore their ideas around barriers and opportunities for translating NRP’s research into practice. The results of those interviews are compiled in the document titled: Research Uptake in Western Australia’s Ningaloo Region: Barriers & Opportunities (2010), which was shared with all those who participated in interviews.

Between 2010 and 2011, the Ningaloo Collaboration Cluster undertook numerous knowledge transfer activities in the Ningaloo region, particularly with respect to the computer models that were built from research conducted in the region, namely the Ningaloo Destination Model (Jones et al. 2011), and the Management Strategy Evaluation (MSE) modelling (Fulton et al. 2011). These activities included the Ningaloo Symposium, numerous

\(^2\) The Ningaloo Collaboration Cluster is a major research project that commenced in the region in 2007, involving researchers from the CSIRO, Sustainable Tourism Cooperative Research Centre and a range of Australian Universities including Curtin University of Technology, Murdoch University, University of Western Australia, Australian National University and the University of Queensland.
meetings and presentations with various local agencies, groups, and station owners, modelling training workshops and public presentations.

Between July and October 2011, I conducted a final round of evaluation interviews with a subset of eight stakeholders representing different regional interests and research interests in the Ningaloo area, including scientists involved in the knowledge transfer activities. The purpose of these interviews was to evaluate if and how a cross-section of stakeholders (including scientists) have been affected by the knowledge transfer process, and reveal the different forms of knowledge that were generated in the process, with a specific focus on changes in:

1. what stakeholders know (knowledge as an object)
2. how stakeholders are doing things (knowledge as action)
3. relationships between stakeholders (knowledge as a process of relating)
4. stakeholder perspectives (knowledge as reflection)

How these types of knowledge were generated and how they are related will be explored in my doctoral thesis. In addition, the evaluation interviews will be used to gather stakeholder insights on what did and didn’t work in the knowledge transfer process, and suggestions for improvements and next steps. These results, together with those generated from the first round of stakeholder interviews, will be examined in the context of complexity theory and the social science literature in my thesis.

PLEASE NOTE, the comments in this document are the recorded opinions of those interviewed and do not necessarily represent fact or reflect the positions of any particular agencies, organisations or sectors.
Knowledge Transfer Evaluation

1 Do you know anything now that you didn’t before?

1.1 General

1.1.1 No

- No. Nothing. But there was a symposium, a Ningaloo Research Symposium in Exmouth, early 2009, that was outstanding. My knowledge increased a thousand fold as a result of those two or three days there, but unfortunately there wasn’t anything like that again. That was April 2009.

- In terms of content, I guess I don’t think I know too much more than I would have got anyway just because I’ve got access to conferences and seminars and directly to researchers and I chat with them quite regularly when they come in. So, in terms of the guts of it, probably not.

1.1.2 Not sure

- It should be an easy question, shouldn’t it? Well, I’m not sure in terms of knowledge, if you look at the models, they’re quite detailed and what you get out of them is really what you ask them.

- Ooh, wow…[It’s turned out to be a tricky question.] Yeah. Oh, goodness… Well, I guess it’s connected us better and myself better with various bodies and things, and that’s been good, because those connections are important, you can always link into contacts then if you get to know people personally, it makes it much easier. And I think that’s been a real plus, having contacts like Beth and Todd and others. They’re really good connections. Because sometimes you know where you want to be but you don’t quite know who to gather to get there. So that’s been helpful, I guess, and is something that wasn’t there before. Nothing else is springing to mind.

1.1.3 Yes

- Yes - research certainly appears to be more available. I’ve seen some public talks advertised locally through eelis and on the notice board certainly not the whole cluster’s work, but there’s been information from a few key ones. I’ve been to a couple of the public talks and, I did learn from them.
1.2 About the Region

1.2.1 General

• I've learnt a lot more about my environment that I live in …Just the number of fish that were taken here, the amount of actual scientific work that has been going on, which I’d never heard a lot of, you hear feedback from it. [Where were you getting this type of information from?] Through you, through the media and through just going to meetings, presentations; the information night we had at the game fishing club and that day we sat here with Beth, Tod and Fabio. That short period of time was very informative. And just talking to people that have probably got more knowledge than what I have and then trying to understand what they’re actually telling me. [So, you feel you’ve got a better understanding of the community and the environment as a result of this?] Oh, much better. More than I’ve ever had and I’ve lived in the community for over 40 years.

• But, when you come to be around somebody that's fully aware of all the things and looks sideways at things, it really does open your eyes…[So, you’re talking about marine life and things like that?] Marine life, the environment, the way people think about the environment, the tourist side of things. For me it was a whole new world and it still is now. [Do you mean in terms of how tourists behave or what they’re looking for?] Yeah. How they behave, what they’re looking for, what damage they can do, do they help look after the environment, the dos and don’ts of tourism – do I want to see my town become more tourist oriented than anything else? Tourism versus the industry or oil and gas or limestone or even the salt farm. [So, do you feel you’re thinking about these things more as a consequence of this?] Oh, definitely, definitely. I mean they were always on my mind. Oil and gas and especially the limestone thing have been there for a long time, but more now that I’ve actually done some work in the industry and seen how things do operate, and then gone to some seminars and listened to people talk, I am a hell of a lot more aware of what goes on in my community than I’ve ever been.

1.2.2 System drivers

• I think probably the biggest part, some of the biggest pressures both socially and environmentally are from things that the locals knew, that Perth doesn’t necessarily appreciate. So Perth knew that there’d be tension between local’s desires, Perth regulations, industry and the marine environment. So they weren’t necessarily surprised that it was so hard to find an amicable solution across the lot. What they don’t seem to appreciate, maybe they do appreciate but they certainly didn’t tell us when we came along, is that paving roads, building toilets, recreational fishing and wilderness fishing kind of ideas were certainly some of the biggest drivers of the system. So when you listen to people in Perth it’s all about grand schemes, state level management, big marine parks and… that kind of turnover, the large industry and turnover stuff. The nitty gritty on the ground though is that the access points – the roads and amenities that are there - both dictates who goes there and the impact that that has, both good and bad. So if there’s no regular sewerage, then what is there goes straight out into the reef which isn’t very good if there are going to be large numbers. But by the same token if you put sewerage there, then more come. It creates its own feedback issues, and a whole bunch of those kind of aspects of the model, about probably a third of what we ended up putting in the model that had big feedback implications, weren’t on the radar of the people who initially set the project up, or it was on their radar but they didn’t tell us that it was important. [So you adding that stuff in, that was...was that a consequence of engaging with stakeholders in the region or some other process?] Yeah, that was definitely from engaging with stakeholders.
1.2.3 Socio-economic environment

1.2.3.1 Exmouth community

- Oh yeah. I know more about my community for a starter. Yeah. I've learnt a lot more about my community. I've learnt a lot more about my environment that I live in, about the community itself. [And how did you learn those things and what sorts of things did you learn?] Just the way the community thinks and the way they don't think, what some of the -- a large portion of the community really want, that's been surprising. Mainly just from going to meetings and being involved with people like yourself and people with the knowledge who've shared their knowledge with me. And, of course, just being an inquisitive soul, on a discovery path really to be able to try and learn a little bit more about the things that I'd been told. Yeah. I think it was just input, input from other people and my own input, trying to, I think it was more of a discovery for myself than anything else, trying to find out things that I thought I knew, which in the long run I found out I didn't anyway.

- [So, you feel you've got a better understanding of the community and the environment as a result of this?] Oh, much better. More than I've ever had and I've lived in the community for over 40 years.

1.2.3.2 Community's interest in the environment

- I guess one of the things I am a lot more aware of is other people in the community's interest and level of knowledge about these things and certainly that reference group just heightened my awareness that there was other people in the community that were quite interested in those things and that the Shire had a keen interest and the GDC had a keen interest and had potentially a more conservation ethic than what a lot of people might assume. Which was good, very positive and I think if nothing else, it certainly opened up the communication channels and allowed us to have those conversations.

- I think the liaison and communication has been the key outcome that I can see from it and awareness of other people's interest and knowledge has been good.

1.2.3.3 Exmouth needs economic stimulus

- Yes. Probably the biggest one has been the degree of direct conflict between the marine environment and the social community well-being. So [using the model], if they froze Exmouth as it was in 2006 and it had no more industrial development, no more extra tourism, anything like that, the ageing population and isolation would've meant that it didn't matter what you did to the marine environment you couldn't turn the social life around. The situation was pretty dire about 20 or 30 years down the track. So if you didn't have any land development but you went for major marine conservation by preventing all development along the coastline and didn't have any industry start up or anything like that, then you'd have a beautiful environment but the community was basically going to age itself to death. There needs to be some form of input on the land side to keep the community going -- the size of that doesn't have to be enormous, that's the decision that ultimately the society and the state and federal (now looks like) has to make, but if that community wanted to survive then something had to happen. That's largely the ageing population problem. The isolation didn't help. I don't know if some brand new technology based on, say, the broadband network could have meant that remote telecommuting might have provided a lifeline for that place. I don't know, that's something you can't predict. But based on existing technologies and the state the system was in 2006, then they needed something to keep the community alive. We'd have done fine for 10/15 years but then it would have just started to decay. And tourism wasn't sufficient to keep them ticking over. Probably the biggest difference between Tod's projections and ours was that Tod knew that there wasn't a lot of growth happening, it's been pretty flat there for the last ten years/five to ten years, so he said 'ok, stepping back and looking at the mid 90s through to now there has been a roughly 2% per year growth.' But it's really been in a big step function that happened about five or six years ago but he allowed for a slow growth in his model, his 2% projection. Whereas I went the other way and I said 'look, nothing's happened in five years, there's
nothing to suggest that there will be another step change, what if you run that forward? If you do that
that means that the society itself would have wound down eventually – like the situation lots of isolated
rural communities are currently facing.

1.2.3.4 Tourism

• Tod’s model, with the tourism, that is more relevant to my work, I guess, and I did get quite a bit out of it
in terms of a bit more insight into different types of tourists and how they contribute to the economy or
the things they like to do when they are here, the different activities they undertake and how all these
things interrelate; where they stay, how much they spend, where they come from. So, to me that was a
really handy outcome in terms of learning something – that is something that was quite useful. [Where
did you pick up that information?] Well, Tod’s destination model. I asked him to show me the different
types of tourist coming to Exmouth and all the other ingredients that you can link with that; where they
stay, how long they stay, what they spend. [Was that during the training process or was that through
discussions or …?] Discussions, yeah. We met him quite a few times when he was still developing the
models and he started to explain it and because there was so much data in it, I found it a bit hard to
comprehend what I could actually do with it until I start asking questions from an end user perspective
and said well, there’s too much in it. But, as a Shire or as a tourism destination; I’m interested in
whether we should target the eco tourist or should we target the fishos or should we target the grey
nomads, because I don’t know what the economic outcomes are for the town or what the
environmental outcomes are or the accommodation requirements or the length of stay. So, I would like
to see it from the type of tourist and then see what hangs off that, which was not the way it presented.
To me, in terms of learning and getting a better understanding of how the tourism industry sector works
in town and how it contributes obviously. [So, you would say you’ve got more of that information from
speaking to Tod or using the model or looking at the documentation?] Speaking to Todd and asking
him and from thereon he was able to use, show me how the model would work and what it could
produce. So, he produced the outcomes. I didn’t do that myself. [So, it was a combination of you two
having a discussion and then him running the model and showing you the results?] Yeah. He would
come back the next day. [So, that was the main thing you looked at?] Well, in terms of what’s really
useful for my understanding and relating to a part of my work, yeah definitely.

1.2.4 About the biophysical environment

1.2.4.1 The marine environment is more fragile than expected

• The problem is that regardless of what of what form of development, if the current management stays in
place the marine system faces serious challenges if extra bodies come into the system. Whether it is
just the resource sector that’s now already planned there, before Wheatstone ever came online, we
know now that Wheatstone’s been given the tick and there’s going to be however many 5,000 or more
people in Onslow, and all the extra people they’re talking about for Exmouth and all that kind of stuff. So
whether it’s that or even a resort or eco lodges or whichever way you wanted to cut it, even if you
stimulated tourism on the coastline, with the current management arrangements there’s going to be a
pretty big toll on the marine environment. So you had to start thinking outside the box if you’re going to
get around that tension.

1.2.4.2 Physical environment is more unpredictable than expected

• The other aspect of that is that through the course of the last even two years, parts of the marine
environment that we thought we understood quite well, out of nowhere it turns out we’ve been wrong.
So no-one predicted that the cold water upwelling [that cools the reef] would ever stop. So regardless of
the physics model, of whatever model you were using, no-one thought that the upwelling would stop
and that’s exactly what it did December last year. So the ‘air conditioning’ stopped? Yeah. The air
conditioning stopped and it got to be a warm bath, and that’s why Coral Bay in particular is just
bleached white or it was in March. You had three cyclones run almost on top of each other within ten days – that's something else that no-one had ever predicted. It actually happened ironically on both coasts. For whatever reason, instead of getting the turbulent mixing down the coast that you normally get, with lots of eddies (which mean that cyclones end up taking slightly different tracks and don’t come in on top of each other), on both coasts the eddies disappeared, they became linear tracks, so on the east coast you got two cyclones, Yasi being the second one, on top of each other in a week. In that case it was probably ironically a good thing because the first cyclone cleared out any of the stuff that would have been a leverage point for Yasi just to tear the place apart. But on the other coast, on the west coast, even though the cyclones were all fairly small, to come in on top of each other meant that the damage was much higher than it would have been the other way. So this is a very informal survey that I swam, I’m sure DEC has much better numbers, it looked like, depending on where you were, between 5 to 15% of the table corals and stuff like that, at Mandu on the north coast, have been flipped completely on their heads. So even though there hadn't been heaps of bleaching in the north, there’d been physical damage from the cyclones. As you came further south, the bleaching was much more extensive particularly in-shore, less so offshore, it wasn’t as bad offshore, but it was a lot worse than any of the models, the physics models, would’ve predicted even for 20 years into the future. [That’s interesting because keep saying he’d never seen the water so warm in his entire time living up here]. Well, I dove in in March expecting my usual sharp intake of breath and it was like being in a warm bath. That was after it had started to cool down again.

1.2.5 Degree of conflict between the marine environment and social community well-being

• So the physical environment is doing things that no-one had ever anticipated. So then you link that back to the tension between the humans on top of this vulnerable marine environment, it makes it a much trickier system than it appeared to be at the start. [And you’ve come to know this through running the model?] Yep, running the model and in particular, and then chasing up on details, like chasing down details.

• It also means that ongoing-wise we’re going to have to keep an eye on how the system changes and then modify the management accordingly. There is hardly ever a simple win-win, but you usually find one more easily than we found with this one, it’s quite a difficult challenge to balance the two sides [development and environment]. The isolation creates its own problem, the isolation and land resources create sort of a tension there in itself, but to marry that with an incredibly, almost delicate marine environment that’s at the source waters of a place that’s going to see an enormous amount of potential change, that’s where it gets tricky.

1.2.6 Why Ningaloo is special

• …also the amount of interest that’s been shown from outside our community from the scientific world, oil and gas world, and tourists, the tourist industry itself. Just things like that. And a lot of it you just take for granted that this is the place I live in. And you know about all the things that are out there, but I guess your interest is, for me, it’s always been an interest but never have I really opened my eyes to actually see what’s there. And then to try and look after it. [In terms of what’s special and?] What’s special and what brings people here, why do I live here, why do families come here that, like myself, who have lived here for 40 or 50 years when it’s only such a very small community.

1.3 With respect to conducting research

1.3.1 Importance of communication in modelling projects

• So CSIRO, particularly the generation that went just before us, they only talked about the big models and the final outcomes and it was that kind of level. There’s now much deeper appreciation across, not
just learnt by our team but actually learnt by our line managers and our team leaders, that communication is as critically important as the science itself and it’s not just the big models, it’s the intermediate models that actually help people think and explore and get the ideas out. And that it’s good to have the big models there to double check so you find things like the tension between the marine world and the land development, but ultimately they’re unlikely to get used so they shouldn’t be overplayed. It’s actually the intermediate models that managers are more likely to play with and expand their thinking. But its the change in the thought process and giving them tools that they can directly play with, that CSIRO now appreciates as important if not more important than these huge, mega computing requirement models.

1.3.2 Barriers to meaningful engagement for modelling

- It was a completely new paradigm for me, parts I knew before, but it was a fairly new experience when I came into the Ningaloo work. But I had a commitment to engaging with the community and the agencies and I wanted it to be a meaningful engagement. Reading the literature of the modelling, you understand a lot of what modelling can contribute is actually in learning – and that requires good engagement. So all this stuff just constantly reinforced it. But it wasn’t really until we went and did it that you start to realise what the barriers really are.

1.3.3 Managing research projects for uptake/engagement

- But I guess yeah, I guess the answer is yes, I’ve learnt about how I’d like to see research projects managed…[How would you like to see them managed?] It really depends on the goals of the project. I certainly don’t think there’s a one size fits all research management. I think, if you really want engagement or you want uptake of the research, then you need a process that is engaged with the managers and people from the region from the start…We went wide initially, we tried to involve the entire community. I think now if I did it again, I’d go narrow and just pick a smaller group of people who were long-termers in the region or people in particular positions, a mix of the two, and just work with them and try to cultivate champions.

1.3.4 Adaptive /flexible management

- You need the management committee to be resourced to do unexpected trips and potentially even actions, and to be adapting itself in terms of what’s going on in the region. So I think there’s that shift we talked about in our paper, from managing the researchers to watching the region to see if new behaviours emerge and then trying to reinforce those behaviours. [When you say behaviours do you mean amongst the different groups or individuals in the region or…?] I guess, in effect the context of what I was talking about refers to the individuals in the region but also really with the agencies and, if you’re thinking from a research management perspective, even the researchers themselves. If someone has something that they want to do that has a lot of support in the region and then they should be able to make a case for doing that. Other projects do run more like that, like the coastal collaboration cluster, Laura’s project is run much more along those lines. But I guess because that’s a research uptake project there’s more appreciation of the importance of that kind of management. Whereas when the Ningaloo collaboration cluster was created, it was seen as a set of projects that could be managed effectively like marine science projects, where you go out, you get the data, you come home and you crunch it, you go and tell people, and then you move on to the next project.
1.4 About communication & Engagement among stakeholders

1.4.1 The importance of face-to-face communication between stakeholders

- The value is in the change and the style of communication, building those networks. The Shire is a really positive example of change in attitude.

1.5 About NRP research & models

1.5.1 Awareness of models (but not actual uptake)

- The models have been quite well introduced to the area, they might not have been picked up and used yet, but that concept and the knowledge about them seems to be quite strong, there was quite a big drive from Beth and Tod and they’ve been here numerous times, explaining, and going over the models, so people are certainly aware of them. The actual models themselves stopped some of the uptake, I don’t know that they’re actually quite at their working point yet.

1.5.2 Awareness of research

- Do you think people around town have a better awareness of the type of research that’s been happening and/or has their attitude towards science and scientists changed at all? Oh, I think they have more of an awareness. How much, that I don’t know, but it’s definitely more than what it’s ever been because there’s a lot more talk about Exmouth now. [Do you think that’s because of the presentations and things…?] Oh, definitely. All the scientific presentations and just the, or normal presentations, they put a lot more input into the community and it’s got people talking. Are they good for the community? I think they are, I think they are.

- … it certainly made me more aware of what is out there and who’s been doing it. So, yeah, it’s definitely opened my eyes to those sorts of things.

- It’s certainly raised our awareness and I think that’s probably half the battle is just making sure that we’re aware of what’s out there so that we can access it if we need it. [As an agency?] Yep
Are you doing anything differently?

2.1 No

2.2 Research

2.2.1 Modelling

2.2.1.1 Expanded the scope of the modelling

I think that Fabio would shoot me if I didn’t underline how much the project changed as a result of that stakeholder interaction. So it went from being completely just on the reef sub-tidal which is what was originally pitched by the CSIRO, by the guys who were the leaders before me, to expanding to be wider than the gulf, it goes out the Montebellos, on the land as well as in the sea. All of those terrestrial components were not in there initially but now there’s farmers and pastures and tourists and all the activities they do on land, literally house-by-house level model of Carnarvon, Coral Bay and Exmouth with 15/16 different kinds of services on land, the regional economy. We didn’t get as much of an indigenous coverage as we would have liked for many, many reasons. But in talking about taking it to the Kimberley, that’s the step that they want us to take next. So, just hugely changed from that, that’s one step.

2.2.1.2 Investing time to help people understand complex systems and use computer models

The other step is that in moving from just being a modeller to leading the team more and more, it started to strike home that within the fishery science world and the places that MSE [Management Strategy Evaluation – using computer models] had been done well before, there was a lot more comfort with taking information from a model. The fisheries management and even some of the fishermen… already kind of knew how to use model information to make decisions. It was probably because the guys who had led the projects in that one, a couple of my mentors, had subconsciously been teaching them how to do it over about a 20-year period, so they were prepped. Coming to North West shelf, that didn’t work very well at all, but I was sort of too junior to have an idea why. Getting into Ningaloo it was quite clear it was because people just aren’t as ready to think about, not just models, but complex systems all together, and that’s the part where by the end of it, about 43% of our time was being spent on activities to help people understand complex systems, to change the way that they think, to help them interpret the model outcomes but also to build simple models for them to play with, all that kind of stuff. And none of that was ever costed in or planned for in the original work as put up by my bosses. So it changed enormously, I think for the better, but it was certainly very different to what we was originally planned.

2.2.1.3 Using a ‘multi-model’ approach

Some of the processes that we used to do in-house just to double check ourselves, have now become an explicit and critical part of the way things are done for the multi-model approach as Fabio has coined it. We used to play around with simple models in-house to help us understand, but it’s actually now explicitly made that a part of the way we do business, where that’s costed into the process, supporting that, and explaining it to people and all that kind of stuff. It’s now being put up as a major milestone step in its own right to share with other people. That’s changed in a way that we’re doing business as well.
• I was at a climate-related effort a couple of months back and it took nearly a week to get across to a couple of ex-CSIRO leaders that having a different model right through from the conceptual to the big one, wasn’t just so that we could convey a science message out, but it was because by watching people play with the simple models we actually learnt about them to come back the other way, and the fact that it’s a two-way discussion was something that hadn’t been appreciated by some of these older senior scientists and I think it’s being picked up on now directly as a result of Ningaloo. [So when you say two-way, do you mean that your stakeholders are providing inputs for your model or…?] Yeah, so part of the wet-ware, as the modellers call it, the human thought processes and how people respond in certain circumstances, is something that social scientists either said you can’t capture, or people have been very leery of having a go, or people have just assumed you could never capture. But what we’ve learnt from Ningaloo is that you can by watching, by giving them simple exercises you’re not only teaching them new things about the system and their thoughts about the system, but you’re learning too about the way people think and make their decisions and that kind of stuff.

2.2.2 Communication & engagement

2.2.2.1 Managing research and engagement differently

• No, I think that’s probably most of it, I’ve said some pretty big things. The way that I’ve managed research, my understanding of what it means to engage, the way I communicate my research – they’re massive things really, so I’m comfortable with that.

2.2.2.2 Communicating science differently

• It certainly changed the way that I communicate my science. So that was a little bit of the knowledge transfer and some other stuff that coincidently happened at the same time. But Fabio and I have done a lot more looking in to how people think and how people take in information. So it’s completely changed the way that I present my science, it’s completely changed the degree or the way that I interact when having conversations. So, I suppose, I kind of already did some of those conversations already but it’s become a much more explicit process, which I now lay out in the formal part of any planning proposal as this is an important thing to have to be supported. It’s been an impetus within the CSIRO for a couple of large visualisation projects to try and help get information back out.

• Yeah, well, certainly the communication. I think I’ve become a much better communicator of research through this project, much clearer and simpler. I put more time into presentations than I used to. So I think since that’s my own professional development, that’s important. Yeah, it’s a tough question to answer if you’re, it’s the kind of thing that if we spoke for an evening I’d still cover other things over the evening, whereas talking about it off the cuff now, I guess it would probably be different.

2.2.2.3 Research focus on stakeholder interaction

• It’s completely changed Fabio’s research direction, completely. He’d gone from looking at how you could use quantum dynamics to model, which is something he’s fiddled around in the background with now, to all of the papers from him in the last couple of years, his contribution to climate change and complexity science and all that, has been around the way people think, world views, how they take in information, how preconceptions modify the way that we think. The same as if we were discussing colour red, are we talking about the same colour? When we see a situation are we actually seeing the same situation or do we have fundamentally different perceptions because of our background? Do the way that people perceive a problem actually feed into how a system is managed and affected and then knock on? And he’s taking this to the climate change stage and is writing with some fairly senior climate change scientists now. So it’s been a pretty big shift. I wouldn’t say for every single member of the modelling group but for those who seriously want to make an effort and make a change and impact, it
has significantly changed the way we do things. [So you guys now view the stakeholder interaction and learning as a critical component to seeing research impact or modelling impact?] Yep.

2.2.3 Adaptive approach

- I think it’s [applying a flexible/adaptive process] going to become a basis for how we do things more into the future, that we’re going to have to have milestones for funding purposes regardless, but we’re going to take it a little bit more adaptively as to what the form looks like or how we do connections. We’re certainly always going to do the kind of ego network connection stuff that [redacted] and [redacted] started up there, with formalising the conceptual model phase and all of those multi-model steps, it certainly looks like it’s going to become a more formal way that we do things. So I think it’s becoming a prototype for how a lot of the research, at least in the next few to ten years, will play out well. I guess after that we’ll see how it worked and whether we need to adapt again. But I think it’s going to have a fairly long-term footprint on the way that we do things.

2.2.4 Spin-off projects

2.2.4.1 Applying for funding to support Ningaloo Research Centre & update models

- And what was the Royalties application for? It’s under [redacted] [research coordinator’s] name, but Russ Babcock and I helped pull it together. In the previous Royalties for Regions effort, they’ve got the money for the community and the actual research centre itself (the building), but there was no support for the staff inside. So we put together a proposal basically for start up funding. I don’t know if it will be successful, December I think we’ll hear whether or not it’s successful. But basically AIMS chipped in in-kind support for the atlas for the next four or five years, the CSIRO chipped in covering its internal overheads for four or five years for one person. So we put up to the Royalties for Regions to cover a four-man actual survey research team to be based in Exmouth by Exmouth locals, for instance divers off the tourist operating boats and that kind of stuff. So taking ideas from the Great Barrier Reef where they had a work for the dole scheme where they used local talent to collect the information and then they just got a couple of external scientists to work it up and build it into a report. We’re looking at the same thing so four people that live in the region can do the data collections, and then basically a one to one a half people from AIMS and the CSIRO to support the models, work up the models, that kind of stuff. [And would that data collection go into the models or to update the models?] Yes, it would. It’s not just what is the state of the ecosystem, because normally DEC is actually down to cover that, and Royalties can’t replace core business of a department. So this would be process based information; how does this part of the reef work, how does this part of the system work? It would complement DEC surveys so together you’d get a much bigger outcome than either one by themselves, both on the social side as well as on the marine side, and plus also the acoustic tags, so the listening stations are still out there but the tags themselves have run out of batteries so there’s a need for a new round to go out and Russ is happy, if the funding got up, to teach the local vet and other people how to insert the tag and stick the tags on and that kind of stuff.

- [So in building the proposal was the GDC or the Shire involved?] Well, the Shire certainly…I certainly spoke to [redacted] and got her perspective on it. The Shire wasn’t written in as a contributor or part of the proposal, we got their approval, we got their acknowledgement and they’ll be interviewed I think as a part of the approval process. The GDC was certainly, they got pointed at as the person who’d be in charge of budgets and the technical corporate head, and we also spoke to [redacted] to make sure it was in line with their desires and would be supported by them in the approval process and that kind of stuff. So, based on the verbal feedback I had, it looked quite positive but it’s again…there might be some other brilliant projects that are being proposed and limited dollars and all those sort of things. It did sound positive.
2.2.4.2 Funding ongoing use of models & research through the NRC (Ningaloo Research Centre)

- [Ok. So the idea for the for Royalties application to fund research staff for the Ningaloo Research Centre arose as a result of the stakeholder engagement, would you say?] Yes. So there’s certainly a desire for ongoing use of the models and ongoing use of the research rather than to just let it peter out, and that was strongly communicated by the stakeholders during the engagement process. In fact, it’s one of the biggest hurdles to the engagement in the first place was they were suspicious that we wouldn’t hang around, and we tried our hardest to hang around but the global financial crisis certainly didn’t help, which meant that our funding has dried up faster than was anticipated. We’ve been playing toss the funding ball internally through my fellowship and a couple of other things to scrape together dollars to continue supporting it, but we have to find a viable method into the future that doesn’t depend on CSIRO largess, because that’s rapidly shrinking. And so that was where this idea came from, that people had been positive, it was certainly a regional initiative that secured four positions, four local jobs totally independent of the CSIRO and AIMS in the region, so it fed the desire for having science-based tourism and a science-based node in the region which is something else that had been strongly asked for by the stakeholders.

- It was just trying to use our experience in writing proposals and funding grants and the science to help answer what they asked for, but also to help support the models and try to be worth the trust that people had put in. So they did eventually put trust in the model as it did answer questions that could be highly sensitive, they wanted to try and be worthy of that. So, we put up over the whole four years roughly $4 million in total. A fairly big ask, I don’t know if it’ll get up or not, but it would really set the research centre on its feet, part of that was also to fund [ ], who has ended up as the research coordinator, to track down philanthropic funding. I don’t think the research centre will ever be self-supporting dollars-wise, and I don’t think government funding is going to be an ongoing possibility. But internationally, civic science as they call it and philanthropically funded science is certainly becoming the most common way this kind of stuff is supported. So the four years is basically to try and get it on its feet and to find that philanthropic sponsor who could at least partly fund it to set up a potential for almost a consultancy role so if Shell or Chevron or whatever needed divers to do any local analysis they could call on that group, it would be a consultancy role for them as well.

- So just trying to set up a business model that would see it continue into the future, so you have long-term monitoring, you have long-term support for the models. And the other aspect was, if it worked in Ningaloo, then they could do the same in the Kimberley, they could do the same further down the coast and have a network around the coastline that completely covered WA. [So would that, who would that be administered through, Beth?] We said that [ ]’s [research coordinator] been nominally down as the scientific coordinator but it would report through the GDC, because they’re in charge of the research centre itself.

2.2.4.3 New projects through new relationships/reputation

- Yeah, certainly, as I said, the presentations, and the next set of projects that I’m working on, really did come out of the knowledge transfer process. There’s the research with the cruise ship tourism proposal at this stage, I had discussions with managers in Exmouth, even though Geraldton initially, but it will hopefully end up in Exmouth as well. There’s the Carnarvon research which came out of talking with the Carnarvon…and also to a degree, both of these come out of my reputation in the region which came out of the knowledge transfer process as well, it was really that engagement part. [And by knowledge transfer, you mean by the people you met, what aspect of it…?] Oh, like the relationships we were able to build and the reputation that you gain from them, I guess, those engagements, those relationships…
2.3 Networking

2.3.1 Improved networks/communication

• Yes. Not so much in terms of the model but because the researchers were here and talking about the model and involving people, the best outcome for me is that it has produced a network I didn’t have before. So, that’s sort of an indirect outcome of this whole thing.

• Ooh, wow…[It’s turned out to be a tricky question.] Yeah. Oh, goodness… Well, I guess it’s connected us better and myself better with various bodies and things, and that’s been good, because those connections are important, you can always link into contacts then if you get to know people personally, it makes it much easier. And I think that’s been a real plus, having contacts like Beth and Todd and others. They’re really good connections. Because sometimes you know where you want to be but you don’t quite know who to gather to get there. So that’s been helpful, I guess, and is something that wasn’t there before. Nothing else is springing to mind.

• I think the liaison and communication has been the key outcome that I can see from it and awareness of other people’s interest and knowledge has been good.

• I guess probably having more discussions with other organisations and groups in regards to what that knowledge, well what that research and information has revealed and how it impacts on what’s going on in the Exmouth area.

2.3.2 Breaking down silos

• [And what do you think the ultimate outcome of that increased connection will be for this area?] I see it being very helpful in particular when we build the Ningaloo Centre, it has given us the starter model, and started to achieve what we want to achieve – communicating science to the general public, connecting science to the general public. So we want people who come up to Exmouth, Ningaloo World Heritage listed region, to know what they’re coming to visit and how to treat it and how to appreciate it and what kind of research has been done here and how that might impact. How they might volunteer or be a part of it. So it really creates an inclusiveness – it’s not just about community, it’s about the visitors as well. Because previously there has been a lot of silo mentality. Each government department working on its own, the Shire doing its thing, the DEC doing its thing, the researchers coming and going, and really none of us knowing what the others are really doing. You’ve got the Education Department doing their own thing, and the TAFE College doing their own thing … This is the beginnings of being able to connect them all, connect them all up.

2.3.3 More openness between groups

• There’s been more openness to hearing the conservation point of view and also been more willingness from the conservation side to share knowledge that’s available. So some of the barriers have been overcome as a result of people just being open and sitting down and approaching it in a professional manner as opposed to getting emotional about their own sides or viewpoints. I think that’s certainly led to a difference in the way our group’s approached and we’re more likely to share information than previously. [So, is that trust related? Why has it changed?] Some barriers were personality driven. Some of the personalities have left the picture and some of the personalities are now more open and receptive and I include ourselves in that. But, looking at the problems with barriers in the past, it might not be that they’re not receptive to the information, but sometimes the information is given to them in a way that doesn’t make them likely to be receptive to it. So, a lot of it is to do with the means of communication and the way information is communicated. [So, do you mean verbally or…] Verbally and written.
2.3.4 Contact with researchers

- [So, in terms of doing things differently, it has more to do with your contacts with other people in the community?] Contacts. There are certain researchers that have certainly made themselves quite available, which is good. For the number of projects that were going, it’s the same researchers appearing all the time, the champions, really out there and making themselves available, but it would appear the large majority are not really in the forefront doing that for whatever reason. I think it would probably make me more likely to contact researchers directly, because some contact details have been made available now, to get their opinions or ask for more information etc.

2.4 Local action

2.4.1 Involved with conservation group

- Well, definitely myself. What I’ve done is I’ve got involved with the conservation management group a lot more. I’ve actually joined now the greens in town and it interests me, that’s made me more aware of the person that I am and the way that I think.

2.4.2 Do things for the community

- Oh yeah. That’s a definite. I want to be more aware of the things that are around me, to join certain clubs and be involved. One of the big things is I want to be involved, I want to be able to do things for my community…

2.4.3 More involved in environmental issues

- I will… I’m already starting a programme of a photographic log of the things that are wrong at the beaches and we’re going to write to the Shire and ask them to be fixed. It’s nothing to do with the tourism side, it’s all to do with the environment because a lot of things are broken, and they need to be fixed because the environment is being damaged by these things not being fixed. So, yeah, definitely. And I’m now at a stage in my life where I can give more to these things and spend the time helping where I consider help is needed, or I can give something back. So, yeah, definitely. [So, stuff about the marine environment, about tourists and that range of things?] That range of things.

- … as I said before, I didn’t know a lot, I mean I knew a little bit but not a lot about that. Having been shown just made me think more about protecting it. Like right now there’s that bio-regional planning. I’m ready to put a submission in there because I believe they’re still giving them too much area to fish in. I want to bring that green part of the chart right back in. [You mean that blue area, that’s open to oil and gas exploration…] Exactly. And that’s why we want to bring it right in and squeeze it up hard so that they can’t, they virtually can’t get in there.

2.5 Sharing new knowledge with others

2.5.1 Generally

- Probably more so directly after attending a specific event.

2.5.2 Within CSIRO

- We certainly share it internally within the CSIRO particularly with [name] who is completely in love with the Ningaloo region. She quite anonymously goes paddling up there once a year and loves the place. Having seen what we’ve experienced and what we’ve found, she’s trying to modify or take
those lessons on-board for other parts of the CSIRO science. So I think informally within the CSIRO it’s having quite an impact.

2.5.3 Research management committee

- And I think the other thing is by being involved in the management committee we were able to communicate those issues to the management committee as well, and to their credit, they were very open to hearing that.

2.5.4 Within the agency

- Only internal, I’ve obviously had a lot of discussions with the likes of the other staff here in the district, particularly the program managers. I’d always have discussions with them after we came back from those meetings about how it, what was discussed and how it impacts on us and those sorts of things. But probably in a wider view than that, not that I can think of, no, I kept it internal. I’ve obviously had discussions with higher managers within the Department as well just to let them know what’s going on and how the group’s working and what it’s discussing, but not, probably not so much externally to the agencies at this point in time.

  - [You mentioned that the one thing you had learned was this idea that we don’t have to do it all ourselves or that other people in the community and other agencies are interested in the research; have you shared any of that sort of stuff with other people, even within the agency?] Oh certainly, yeah, that’s what it was…[So, your own staff and staff outside of Exmouth?] Yeah, yeah, definitely. Certainly my regional manager but also I’m sure I’ve had discussions with at least one of the directors about what the reference group’s doing and what it’s trying to achieve.

- And I think there’s the general knowledge transfer process and the models and those sorts of things. I’ve had several ongoing discussions with the director of Parks and Visitor Services about the models and how they can be used and those sorts of things. I’m not sure that it’s led anywhere but those discussions have been had, sure. But the director of Parks and Visitor Services has been involved with some of those modelling exercises as well, he has attended them. So I think there was one run down in Perth at one stage that he went to and I think some of our other planning staff have been involved as well. So, yeah.

2.5.5 Reports and scientific journals

- More formally through the peer review picture, we are trying to load up at the present moment, it’s a little bit tricky, there’s sort of no particular natural place for it to sit. There’s certainly literature about how you engage with people and do that process, and in some of that they already know these lessons, I think there’s still some new lessons in there but they kind of know. The hardest part is trying to get it across to the science audience that really does need to know it.

- Yes, I think so. Certainly I think the final report picked up on these issues. And I think [ ]’s research is also identifying them as well and it’s interesting to hear, good to hear him acknowledge you by name in his presentation yesterday. So I think those two projects will manage to communicate what the interaction was like, and its importance and also, certainly in my case, your role, and the influence you had on the project. So yes, I guess, more formally yes…to some extent in presentations, definitely in publications, and hopefully we can do a few more down the track.

2.5.6 With Shire council, tourists, operators

- Well, I did send out some powerpoint presentations that we were given by Tod and Beth, and shared some tourism-related information with other people… more the tourism, because that’s the most
important part for my line of work. But, yeah, I did talk to other people about it and when people say oh, grey nomads this and this, I can give them a bit more background information about what they actually do for town: yes they stay very long, but the daily contribution to our economy is not that high as two people in an old Combi van. There’s a lot of talk, for example, about the backpackers in the Wicked van camping illegally somewhere and not paying 30 bucks for a caravan spot, but what people quite often forget is that they are the people who are more likely to go on a $350 whale shark tour. So, their contribution to the local economy might actually be higher than people who stay very long at a caravan park and bring their own potatoes. But that’s from talking to Tod and him being able to show me those figures – it’s given me the opportunity to actually talk to people …[And so, those people would be…]

2.5.7 Shire and community

- I guess from a Shire perspective– yes, we talk about that in our community meetings, Shire meetings and newsletters and the…I mean in terms of telling people things that you’ve learnt through the process?] Yeah. And trying to get them to understand. Also explaining to them that I don’t fully understand a lot of it either, but I’m trying to and I only see the good side of it, I don’t see any badness in what a lot of these people are trying to do to help our community. Unfortunately, I’ve realised that most of this type of thing comes from outside our community with people like yourself.

2.5.8 With other community members

- So, now I’m trying to use that little bit of knowledge that I’m getting, and I want to try and relate that back to my community and how I do that is the only way I can, is word of mouth. So, yeah, in that sense it’s been, it’s taught me something and to be able to give back really, that’s what it’s done. [So, your network’s changed. In terms of your actual day to day business has anything else changed other than what you’ve just stated?] No. Not really. Like I said, for me the networking is the most important thing to come out of it. I know we’ve all been given the model on the data stick and we can use it in our day to day work, but I don’t, it’s just not the type of work I do. I’m not a researcher; I don’t need detailed information, and I don’t do that type of that long term planning either. I’m not a strategic planner or a town planner as such. [You attended the model and training workshops didn’t you?] Yep.

2.6 Governance, planning & management

2.6.1 Model use

2.6.1.1 Not using the model

- if you look at the models, they’re quite detailed and what you get out of them is really what you ask them. What I’ve done is basically play with the model, I haven’t really used it for serious work or serious research. It’s probably not the nature of my day-to-day work that I would require insights into what the model can deliver.

- [You’ve noted that your work doesn’t directly involve the models, but do you think the Shire would have a use for the models or will use the models, whether they use them themselves or they ask someone down south to run a scenario for them?] I don’t think we’ve got the skills for it or the time to do extensive research. We’re a smaller community and we basically have to get on to things or get an external
consultant to do it for us. There’s just too much going on. [To run the model yourselves or to...] Well, to understand the model I think yes, we had the training but to keep your skill and your understanding up, you have to use it on a regular basis otherwise it disappears. So, you have to invest in the model itself and it’s not like Excel program or Word, where you do training and you use it on a daily basis. So, that’s the risk a bit, no matter how simple you make it I guess, how user friendly you make it.

- [Do you think there would be or has been a point where the Shire has a proposal or something come through where they would ask after someone to run a model scenario?] No. I don’t think there has been at this stage. I would think these requests would come more from maybe Fisheries or DEC, not so much from the Shire. Especially, Beth’s model, which is really ocean based, we don’t really have a role there as the Shire. [I guess I’m just thinking in terms of the proposed oil and gas supply bases for example, whether the Shire would be interested in using the models to look at what the relative social, economic and environmental pros and cons would be?] Well, there could be one coming with a local business putting a proposal on the table, I’m not sure where that’s at, at the moment. It could be an option that, say, our planning department want to have a look at it. [But, at the moment it’s not on the planning department’s radar to give Beth a call about these things?] I believe there’s now a formal planning application in from the company and there’s a turnaround of around 40 days or whatever. So, where’s your time to do extensive modelling and analysis? Again, our planning is not in the water, it’s on land so it goes back to state government.

- I know we’ve all been given the model on the data stick and we can use it in our day to day work, but I don’t, it’s just not the type of work I do. I’m not a researcher; I don’t need detailed information, and I don’t do that type of that long term planning either. I’m not a strategic planner or a town planner as such. [You attended the model and training workshops didn’t you?] Yep. [So, now you’re not actually using the models but the side benefit was the relationships you established in that?] Yeah.

2.6.1.2 Using the models

- The models, yeah, is something that everyone here is still quite keen to use and in fact we’re looking at that, potentially trying to use those in the near future. [So that could be a change in things that are happening?] Definitely, definitely, that’s put a tool (if you like) within our reach that could be very useful to us. We’ve got proponent driven developments that are wanting to happen, and the modelling will be a great little tool to say ok, if that goes ahead, what happens here? And I think that will be very helpful in part of the decision-making community will make and Shire will make. [So you can see the models actually being used in the future by the Shire?] Yes. Yes, I do. [Do you think yourself or perhaps the Shire will do things differently in the future as a result of this process?] Yeah, yeah, definitely, already we’ve begun to do that.

- I’d like to think that we’ll use the model in the future as well for some of our day-to-day park management or justification of some of our day to day park management. But, as I say, I’ve got to get over those other concerns as to how that fits in. It always provides for the good base line to work from, use the model and say this is what’s predicted, yeah a few things have changed but worst case scenario…is you can use it to model worst case scenario type things and work upward from there. I’ll definitely be keen to try and use that in the future.

2.6.2 Applying for an environmental officer

- I’m not an environmental officer, and we don’t have an environmental officer in our organisation. It’s one of the things that I wouldn’t link directly to this program but we recently submitted for a grant application to try and get an environmental officer in the Shire. So, if we’re successful we would have an officer for two years, that’s the aim, the starting point. And the idea is to make that a, well as a working title I call it a community environmental officer. Our priorities as a Shire are within the town site and the community, so the position would work on environmental programs with a community component, to inform the community about recycling, clean-up days, information for visitors and tourists and to work with DEC, on our revegetation programs, whatever you can come up with that has
2.6.3 Community consultation

- Yeah, well, you know, I guess just in our way of trying to communicate to the community, yes, we are doing that differently. And trying to take the community along and also get the community to really drive what they want for the region based on all the factors – whether it’s the environment, the socio-economic stuff, the whole… trying to get everyone to really set the direction for the town so we end up where we want to be rather than where we’re pushed. So, yeah. The more we communicate and the more contacts we make, the more we’ve been able to do that. But I don’t know if that’s answering your question. [Do you think that some of these so-called, what I’m calling ‘knowledge transfer activities’ contributed to that?] I think they do, yes, I think they definitely do. The more you talk and the more you communicate, the better people understand. And you draw out viewpoints and you draw out knowledge and I think that’s a good thing. You can’t not talk too much, you know.

- [And as for the Shire deciding to do more out-reach to the community and consultation. Is some of that as a result of the research program and what’s happened with that?] I think it is in part because the more we dig into what we want to do with the Ningaloo Centre, for instance, and wanting to communicate research to the community and to visitors, the more we’ve had to let the community know what our intent was, so they understand that’s what we want, that’s what we want to achieve. So by communicating and by having these community meetings and things like that, we’re finding it easier to get that message across to people. So hopefully, hopefully once we do achieve the Ningaloo Centre and we have that research component there, people will understand that this is something they can touch and feel and learn from, and easily and readily go to – rather than it being some far off removed thing, because research has been something quite disconnected from them.

- [I wasn’t here but you guys hadn’t been doing quite as much community consultation before, so is this a new thing…?] No. No, there’s been a couple of workshops with the community and we put out information flyers and that sort of thing. But yeah, I think this interactive kind of communication is far better. Once upon a time our ratepayers meeting was our main source of communication with people and more often than not people who came to the ratepayers meeting came with a gripe, if they came at all, so you’d only get a handful of people. Whereas with the new way of doing things, we’re getting a lot of people’s interest to come and get informed and if they’ve got a question they can ask it. So I think that’s far more relaxed and freer and, yeah, and it’s building better bridges with DEC and, yeah, the whole mood’s better.

- We’ll do a whole lot more in terms of community liaison and consultation and I think the… I think we’re just fortunate that we’ve come in… well, I’ve come in at a time when we’ve got a Shire CEO and President who seem to be very proactive and they’ve taken on board this whole community consultation and keeping people informed and I guess we try to do it, but the opportunity is perfect to work together and make sure the information is flowing out those sorts of things. So, we’ll continue to make sure that we keep everybody better informed and so, we now do things like… they’re pretty basic but the Coral Coast Newsletter that we’re sending out on a quarterly basis now and attending community meetings and if there’s anything on as required and just trying to get the information out there a whole lot more. [Is this partly a consequence of the knowledge transfer activities that have been part of the research program?] Yeah. I think it is.
• I think back to what difference that knowledge transfer process has made. To me it’s made the awareness that the community does want to know a lot more about what’s going on and half the problems that come from negative community perceptions is based on lack of information rather than they’re actually necessarily disagreeing with the idea. So, I think from my point of view that’s a key for our success and I don’t mean success in making sure that we’re seen as fantastic, I mean success in terms of being good managers to the environment and making sure that everyone’s getting out of it what they want to get out of it, is just keeping people informed. But, in saying that, it is difficult in a place like this because people just get overload of information and you go through waves of, yeah, everyone’s excited and then you’ll be running these workshops and things and no-one will turn up. So, you’ve just got to go with the flow on those sorts of things.

• So, yeah, I think we’ll continue to have the increased community liaison and dispersal of information.

2.6.4 Planning & Management

2.6.4.1 Adaptive management

• I’m not sure if it’s as a result of that particularly process and the reference group and those sorts of things but we’ve certainly got a whole lot more of an adaptive management mind set to the way that we’re dealing with things here. And I don’t know whether that’s because of what’s happened or because of the research that’s happened and also just because adaptive management is a bit of a catch phrase at the moment, it seems to be the accepted norm these days and it makes sense. So, it’s probably, certainly raised my awareness of that adaptive management and that’s been pushed quite strongly. [Was that to do with Beth and Tod?] Yeah. I guess Beth and Todd and yourself and meetings that we’ve had with them and that whole model process is basically revolving around an adaptive management technique where you can model what you think is going to happen but then you still have to have the things going on in the background to test whether those models are coming to fruition.

• I think from our point of view, our programme’s probably evolved to a stage now where we recognise that we need to be far more accountable and far more responsive to things that are happening on a day to day basis. The old process of setting the management plan in place and then just letting it run for 10 years and then coming back to it afterwards and changing your practices just, it doesn’t happen any more. So, we’re in a far better position and all this research has put us into a far better position to have a better knowledge base to work from and carry on that ongoing monitoring and adaptive management from. So, yeah, so I guess it has…we’ve changed, some of which is linked to this, I don’t think it’s all linked to this, I think some of it’s, as I say, a natural evolution within our department or within our…well, within the marine science branch probably.

• [what do you think has changed: going from running a management plan for 10 years to how you’re thinking now?] Yeah. Good question. I guess it’s just a – I presume it’s just a recognition that things don’t happen over a 10 year timeframe in the natural world, it’s just…things are happening on a constant basis, they are changing constantly and by keeping a good close eye on it you’ve got the opportunity to respond. Unfortunately a lot of the things you can’t respond to, there’s nothing you can do but certainly it influences our management regime in terms of responding where we can and where it is possible to alter something that is obviously introduced. I think the coral bleaching event that happened over this summer has sort of reinforced the value of having up to date and live information coming in and live research coming in. Yeah. If that hadn’t been getting monitored on a day-to-day basis it would have just been assumed it was a normal year, not that we can do anything about it, but…[Yeah. But at least you know that it was definitely an impact]. And at least we had some base line to go, ok, there actually is some significant damage happening here and we need to at least monitor it and figure out if there’s anything we can do or figure out if there’s any other impacts that we can manage that will reduce that sort of flow on impact, if that makes any sense.
2.6.5 Applying research

- And I think just a few of the ideas that have come up in terms of research seminars in the community and those sorts of things we’ll use and all the information that comes out of those researchers we’ll obviously use in our day-to-day management where it’s applicable. Just knowing what’s out there and knowing how it’s impacted and knowing how it’s affected and knowing how it’s changed. I’d like to think that we have the ability to improve our day to day management as we can.
3 Do you associate with anyone new or differently?

3.1 No or little change

- It is difficult to distinguish some things because there are new people or processes and contacts we’re associating with because of the turtle program, but a lot of that has to do with the turtle program itself and relationships that we’ve created by it, through it and for it. I would say stepping away from that, certainly that had introduced new partnerships, new alliances, new information but stepping away from that to do with the Ningaloo cluster or the modelling... we haven’t had those partnerships or anything new come concretely as a result of that other than, for example, relationships with people like yourself. [Is there anyone else that you would say you’ve got contact with?] Other than you and Beth Fulton, no.

3.2 A little bit

- [So, your network’s changed. In terms of your actual day to day business has anything else changed other than what you’ve just stated?] No. Not really. Like I said, for me the networking is the most important thing to come out of it.... [So, now you’re not actually using the models but the side benefit was the relationships you established in that?] Yeah.

- Do I? No, probably not. I think it’s all the same. I think I still, I go to meetings now where there’s a lot of different people; do I associate with them at the meetings? Yes. I guess now those people don’t walk past me on the street anymore without acknowledging me, where there was a time when you’re strangers even though you live in a small community, because you don’t interact or interface with these people. Now, it’s like, well yesterday, getting a call from somebody that I didn’t really know a lot. So, yeah. I guess not a lot but probably more than used to happen, yes. [So, different, people from different groups or different, government agencies... Different walks of life. But not on a grand scale, but definitely I’m intermittently in contact with different, other people that I’ve never mixed with before.]

3.3 Scientists

3.3.1 Researchers generally

- Even with the researchers themselves, I knew Tod a little bit already, but people like Beth, it’s really handy to ask her a question or give her information. [Have you done that since?] Yeah. As an example, we had some Orcas attack some Humpback Whales not so long ago and there was a movie going around. I just sent it to her and said do you know about it? She said we always expected a pod of Orcas to be following them but I’ve never seem them... whether it was useful for her in her work or just out of interest but, and then I asked her some questions about the reef, about the length of the reef and she fed that information back to me. Whether something comes out of it or not, at least we can keep each other informed so, that happens on occasion. And again, to me, the networking that comes out of that is important. I’m not a researcher myself.

- So, in terms of doing things differently, it has more to do with your contacts with other people in the community? Contacts. There are certain researchers that have certainly made themselves quite available, which is good. For the number of projects that were going, it’s the same researchers appearing all the time, the champions, really out there and making themselves available, but it would appear the large majority are not really in the forefront doing that for whatever reason. I think it would
probably make me more likely to contact researchers directly, because some contact details have been made available now, to get their opinions or ask for more information etc.

- Yes, definitely, yes. We always had a bit of interest from Curtin University, people like [redacted] and [redacted] have made themselves very available to us for a long time, but this has created a larger network into different departments and into agencies such as CSIRO and... [So into the research institutions?] Yes, even UWA and, more connections.

### 3.3.2 CSIRO

- [Has anything come out of the contact with Beth?] Yes. It's been very positive, for example, because of the face-to-face introductions and contacts we had with each other, we became aware of what the other was doing. Beth requested that we release our Gnaraloo turtle data to her for input into her model and then referred other people to us who also requested release of our turtle data to them to influence their work.... certainly the contact with Beth is ongoing and valuable. We've just recently had contact by other CSIRO people that want to put our turtle data into the TERN database. The Terrestrial Ecosystem Research Network (TERN) is a sub-set of Australian Ocean Data Network (AODN) and that's through CSIRO. And that's where we find value, when our data feeds into their databases, into their modelling. We feed out a lot, we haven't had that much being fed back into us. Nothing against anybody, it's just that, for example, we're still waiting to hear about the Ningaloo Cluster's results and findings. We'd like follow up from the Exmouth Symposium 2009. Because the Exmouth Symposium 2009 was just outstanding.

- And then there's the CSIRO who I've done a lot of publications with. The relationship with Beth - getting to know Beth has been one of the great pleasures of doing this work, and spending some time with her. And Fabio as well.

### 3.3.3 Other scientists

- Yes. We associate not just in the reef in itself with a whole bunch of new people, not just researchers that have come together as a part of the research like Tod. Within CSIRO it's brought down some barriers between social science and the physical sciences, there's some more common ground. Unfortunately the particular people we've found most helpful to work with have since retired or moved on to other jobs, but it has been a foot in the door to get closer collaboration between those groups to try and get over some of the semantic hurdles I think that have held us apart. We've been trying to now build within our team, within the biophysical world, more social scientist positions, but there's a bigger expectation now that it's not just the biophysical world but the social and economic have to be in there on an equal footing every single time.

### 3.4 Local agencies and groups

- I think it's a bit too early to say if the local connections will continue into the future so at the present moment they seem to. [redacted] sends us a semi-frequent update on how things are going up there for instance, but it'll take some time to see if they continue and whether DEC continues its engagement with Hector over the models and all that kind of stuff. But at the present moment it does look like a degree of local connection is much stronger than in the past. And that's something again that CSIRO hadn't necessarily appreciated before, there was a lot of high-level networking and negotiating and all that kind of stuff with department heads, but on the ground, local government and residents and all that kind of stuff isn't something that the CSIRO had encouraged or even seen the need for before. [But now you guys have found that you are associating with some of those people on the ground?] Yep. Some of the CSIRO upper echelon appreciates the need, but not everybody, I think it's still seen as a new way of doing business but I think it's something that's certainly helping our understanding of the system.
Yes in that ______ has emailed us a few times, the Shire occasionally gives us a bell, ______ emails us particularly when there’s an oil spill or a new development. The Cape Conservation Group sporadically emails, I think that’s becoming more through you and ______ [research coordinator]. In trying to write the Royalties for Regions grant, there was a lot of conversation with GDC and the Shire and other people up there. There has been an ongoing contact and if that position, if the funding comes up for that Ningaloo research group up there, then I think that relationship could continue for quite some time into the future.

Definitely. There’s a few key parties, for example the Shire and GDC. There’s been some limited contact with the research coordinator. Some of the Councillors; there’s one in particular that’s very interested in learning more.

Ok. Yes, there are some differences the lunch meeting that you arranged, has certainly strengthened ties between stakeholders so; that’s had a positive influence.

I think CCG’s relationship with Shire has really strengthened recently. [With the reference group meetings you mean or the…] With the reference group meetings, probably one of the strongest ties is actually sitting down and listening.

[You were involved in engagement with stakeholders throughout the region prior to my arriving on the scene?] Yes, I was, and that’s probably something that’s worth recognising. I came in with David Wood, of course David’s been working on a range of things in the region since the mid-90s. He was the chair of the Ningaloo Sustainable Development Committee, and so he had a set of relationships in the region that I was able to leverage and work off. And yeah, we did have relationships but I think because you were based in the region you did bring in other people that weren’t engaged at that stage. So I suppose there’s the quality of the engagement but then there’s also different people who got involved – and quite important people too, like ______ from the Chamber. He sat on the local committee. ______ with the GDC, got more engaged, and then the Cape Conservation Group who I’ve been speaking to the whole time

Yes. I’ve had ongoing contact with ______ from the Shire. And I tried to get a project up on the whale shark tourism industry through DEC. It didn’t get up in the air, but it came out of those relationships.

I’ve got quite a close relationship now with the Aboriginal Cultural and Heritage Centre in Camarvon, though they weren’t really engaged with the research, it was just kind of incidental. They made use of some of the tourism research in some of their proposals, and I was interested in what they were doing. It coincided with another research interest of mine but I had the opportunity to meet them through the process.

As for other people, I know most of the players in region at the moment, some are different from what they used to be. That’s come about because of the engagement as well. In terms of doing research in the region, I’d probably be as connected as almost anybody at the moment.

Yes, certainly with DEC locally. Definitely creating a better relationship there and I think not just the Shire and DEC, but the community and DEC. And I think that’s the beginning of a better relationship so we hope that that will improve and increase…It’s been lacking before, there’s been a real disconnect between DEC being seen as a regulator, if you like, or policeman rather than serving the community for its benefit, I think. [Did the reference group have an influence on any of that…?] I think that helped, yes, because you’ve got people like ______ who are involved that’s dealing with the whale research work, and you’ve got DEC involved and we’ve got the Shire involved, GDC involved, so there’s government agencies and researchers involved in that group and those sort of connections build bridges and relationships. You can’t really put a value on that kind of network stuff.

I think the relationships between us and the Shire are great and I think some of that’s as part of this process, some of that’s the people involved with that process.

Certainly the GDC I see in a slightly different light than what I’ve seen them previously and, once again, partly because of this process and partly because of the person involved.
3.5 Community members

- I guess just some members of the general community who I didn’t think had an interest in a lot of the day to day have popped up and you sort of go, oh well that’s great, it’s a surprise but it’s great. And you see that there’s a lot of people that aren’t just associated with the likes of the Cape Conservation Group and those sorts of things who have actually got a really deep interest in what’s going on and the future of the place. So, no individuals in particular but just a general feeling within the community that there is that interest there.

3.6 “Environmental” types

- [Going back to your networks: you’re interacting with more people than you were before?] Oh, with a different area that I wasn’t really well connected with. [Ok. And how would you, and that’s primarily with the environmental-type people?] Yeah, yeah, yeah.

- I didn’t know [locally based scientist] before, didn’t really talk to DEC officers, but because the researchers came here and brought us all together, that has established something here in Exmouth I hope that will continue, even if it’s just sharing our own information, whether it’s from the model or not and I think that is something that Exmouth really needed. There is no environmental platform here, where people are involved with looking after national parks or what we do in town. There was a get together, and I think that’s one of the spin-offs that is really useful, yeah.

- [So now you’ve got a better network? How does that contribute to your work and how do things at work?] When I do have questions, it’s relatively easy now to call someone and ask for help. Because I’m not a specialist in environmental questions or topics, but I can now call [locally based scientist] . Sometimes, say, from a tourism perspective, Tourism WA might call me and say it’s Humpback Whale season, can you tell us something about it. I can call [locally based scientist] now and say you’re one of the experts here, have you got any interesting facts or data that we can use in promoting the reef here. This is simple example, in the past I would wonder who to call. [So, from your perspective, that’s easier than finding a report?] Yeah. Definitely. I wouldn’t even know where to start for Google now.

4 How would you describe the nature of your new/changed relationships?

4.1 Warm professional

- I think a warm professional relationship with most people, certainly in the region. I’ve been doing research long enough to realise that by coming in and asking questions like researchers do, it’s actually fairly difficult to become close friends with the research subject – and that’s fair enough; you’re an outsider, you’re potentially collecting information that could be quite personal or even detrimental to someone’s interest. And so they’re going to view you with a degree of caution, and also you are asking about insider issues and you’re an outsider, then there’s going to be some barriers there. So I think I’ve always gotten along with people there and I’ve enjoyed and I’ve certainly tried to make my engagement with them enjoyable and not dreary or some kind of work. And I think that’s appreciated. So I would say it’s a more professional relationship with most people, then there’s a few people where it’s probably gone beyond that, like [locally based scientist] with the Shire I would say is a friend now, and Beth and [locally based scientist], and certainly all of the students in my project, I’ve got a pretty good relationships with all of them and that’s been really good fun. And [locally based scientist] and some of the other researchers here in Perth. [So that, so how does that affect the quality of your interaction with these people, the fact that it’s maybe gone a bit
beyond…?] It’s better, in terms of this kind of engagement. The better the relationship is, the greater the chance that the people are actually going to learn something because they’re paying more attention and they’re more engaged. So it’s positive as far as I can see.

4.2 Professional and friendly

- [Would you describe the nature of these relationships as formal or informal, friendly, professional?] I’d say all of the above. I’d say it’s very professional, but it’s accessible, it’s friendly, but friendly and professional don’t mean that you’re just saying what the other party wants to hear. Because mature people can have debates, discussions and differences of opinion or agreement and be open to change. People have come across our paths and changed our point of view. That’s all we ask, that sometimes what we say may influence what others think. [And then that friendliness, does that affect the quality of the interaction?] I think so. It didn’t start off as hostile, antagonistic or mistrusting and from there it continued to built. I just feel that you guys didn’t come in with a made-up mind, point of view or resistance to us. It didn’t mean that you condoned what we did or didn’t do or, were for it or against, it but at least you gave us an open hearing.

- Well to me I think it feels informal and friendly. But with a, obviously a good professional background to it. I think it’s developed a position of respect as well that’s, friendly and informal but with an understanding of Shire’s needs and position and they’ve got an understanding of our needs and position and GDC’s likewise. So, I think it’s made it so you can just have a chat and not feel like you have to have a formal chaired meeting every time you need to discuss something, which is excellent.

- There’s a huge range, there’s some that I would certainly say are professional only and I wouldn’t say anyone is cold but I wouldn’t put everyone up there. But there’s certainly some new friendships that have been formed both within the science team but more broadly than that. There’s quite a few unique characters up there that have wormed their way into our hearts.

- I’d like to think it’s friendly and professional. I think the more informal you can be, the stronger the relationship becomes There’s obviously times when you have to be formal, but the friendly and informal is what adds the value to the relationship.

4.3 Informal and friendly

- Oh, very informal. It’s not like we’re working on a project so, it is informal and on an as-needs basis, which really helps in my work.[What the ‘feeling’ of the relationship?] Oh, pretty friendly. Like I said, it’s informal so, it’s not like I have to meet with them, it’s because we want to or there’s a good opportunity to get in touch with each other again. [You enjoy the interaction?] Yeah. I like to stay in touch with these people and they’ve got interesting information and ideas that might not be mine, but that I’m happy to grab.

- [How would you describe the nature of the relationship with these people? Is it friendly, is it formal, is it hot, is it cold, like, what’s the…?] No, it’s very warm and very open and friendly. I definitely feel very, you know… All the research bodies and people that we’ve been connected with are very open and approachable and, yeah, there’s no formality about it all really. I think that’s great. [That’s what’s helped facilitate…?] Yeah, I think it does, you know, as you build relationships you get to know people, it’s much easier to be informal and feel, you know, I certainly feel like I could ring any one of those people that we’ve been connected with at any time, or email them at any time, and get a happy response.
4.4 Friendly, but not that open

- I think it’s friendly. Yeah, I think it’s friendly. I don’t think it’s as open as what I’d like it to be, because that’s the type of person I am. And I also have to realise that people are wary because we do live in a small community and it’s very hard to put your hand up sometimes because if you put your hand up you’re seen to be the black sheep. So, I understand that, but I believe that if you want to be involved in something and you’ve got to push a cause, then you’ve just got to put your hand up. And the consequences of it, well hopefully the people are open minded enough to realise, to believe that that’s what you believe.

4.5 Inclusive, candid, respectful

- [So in terms of the nature of the interaction, say, that you have with myself and Beth; how would you describe it, how do you feel about us, I guess?] I would say it was an inclusive, candid, information exchange. It didn’t mean we always agreed. We could say things to you that you may not have agreed with, you could say things to us we may not have agreed with, but it was very respectful. It was a dialogue and we found that you took on board and at least considered what we said and we certainly did likewise. I think it was a very positive style of consultation or communication. And the fact that you even went out of your way, all of you, to come to the station to meet with us, to come to where we were if we couldn’t get to where you were, to understand if we couldn’t get to you because we had other pressing problems or site pressures.

4.6 Accessible

- It was very good to have the initial face-to-face meetings, because now we don’t feel remote from contacts such as Beth Fulton even though she lives and works out of Tasmania and we are in Western Australia. That’s quite a feat to have achieved that, she feels totally accessible to us, we don’t bug her and she doesn’t bug us, but there’s open communication channels and we’re aware of what the other one is doing and we let each other know if there’s something new that comes up that the other one may be interested in. It is very good considering that I’m in regional southwest WA, in remote regional northwest WA and she’s in Tasmania! It doesn’t feel remote or isolated between us. I don’t feel like I don’t know what Beth’s doing because she lets us know when there’s a key or significant development, and if we’re interested, we follow up on it and vice versa. And where we can help each other, we do.

4.7 Prepared to share (scientists)

- [And do you feel like, in terms of some of the scientists and researchers you’ve met, what about that? What was the quality of the interaction there?] Yeah. I was very happy. The ones that I spoke to I always found very happy, they’re more than happy to share their knowledge. Sometimes I think, and it’s obviously for layman again, scientists are very hard to understand because that’s the world they live in. But, a lot of people, some scientists I’ve met now, are finally starting to get the fact that when they’re talking to layman, they have to come down to their level and I know it’s hard for them because they live in the academic world. But, because people like myself don’t live in that academic world, we need to have it explained to us on a plane that we can understand. And I’m sure that a lot more people, a lot more scientists, the ones I’ve spoken to, are now more prepared to adapt, to change, than they ever were. Because, at one time if they couldn’t relate to you, they just didn’t bother with you. [Has that been your experience up here in the past?] Yeah. Very much so. But now, I think they’re more prepared to share their knowledge with you on a more simplistic basis, which I think is important. Because if they want people that live in the community to support what they do in our community when they come into
the community, if they put it on a level that most of us don’t understand they might not going to get the help that’s required.

4.8 Trust

- I think people are always professional about answering questions, but when it comes to the truth of the drivers of the system I think you get a better perspective if you’re trusted and respected, which comes with friendship. So if you’re in a public arena standing up in front of a public audience of, you know, whether it’s in the big resort up there or the recreational fishing club or whatever, you often get very economically based feedback in what their concerns are. If you’re asking them over their own kitchen table or over a beer at the pub or whatever, you start to get the real social impacts and their social concerns. It’s as much about the image that they’re putting forward and how they want to be seen around the town, you get a very different perspective, and there’s at least a couple of people up there it’s very context dependent (on how you ask them and where you ask them) as to what you get. If you only heard one side of their story then you would actually miss out on some of the biggest feedbacks that are driving how that system works. [So in terms of what their motivations are]. Yep.

4.9 Negative

- [And has the nature of your relationship with any people changed?] Oh, definitely. And some of it’s been good, some of it’s been not so good. World Heritage was a classic example. A lot of my friends or my associates knew the way I felt about World Heritage and now that it’s in, some of those people, they’re still friends, but they think very differently towards me and quite open about their comments about World Heritage being no good for the community. And they say those things not knowing, unfortunately. So, yeah, that’s been different. [Have there been some other positive changes in how you interact with folks?] No. Not really. I think it’s just pretty all stayed the same. The negativity is the thing I’ve noticed more.

5 Has your thinking or perspective changed on anything?

5.1 No

5.1.1 Except for Ningaloo Symposium

- I have to be dead honest, no. Except for the one event that greatly affected my thinking professionally and as a result my advice out to Gnaraloo and therefore management action on the ground, and that was the 2009 Exmouth Symposium. It provided me with new information, it gave me access to new ways of thinking, pieces of information that I then could convey to the tourism managers at Gnaraloo who are on the ground and deal everyday with the public and their recreational use of and impacts on the Ningaloo coast.
5.2 Yes (general)

5.2.1 More insights/awareness

- Well, it’s given me insights, like I said, don’t ask me about percentages or figures or whatever that the model can show, but it’s created a bit more awareness I think. Yeah, I don’t really know how to answer that. There are only the few things I’ve mentioned before. [So, has you’re thinking or your perspectives changed?] No. Not really, no. [Ok. Just a little more insight on a few things then?] Yeah. I think so and it’s given me a bit more information, a bit more background I think that I can use when I talk to other people.

5.2.2 Strengthened existing beliefs

- Oh, definitely. That’s a definite. Without you coming in to Exmouth and me not meeting, that’s not to say I wouldn’t have had some of the same beliefs that I have now and probably stronger but being around somebody that is world minded about the things that go on, not only here but in the world and having those explained to and feeling very strongly about it too.

5.3 Communicating/getting information out

5.3.1 New ways of communicating

- I guess it’s just opened up other ways of communicating to people. And that’s a good thing because, especially from a Shire perspective, you’ve always got a community where there will always be people who say that we don’t know anything that’s going on. So having more ways and avenues for opening those lines of dialogue, is better, is good. [So just the idea of doing public meetings…] Public meetings, and our CEO’s idea of creating the Heads of Department meeting – those sort of things, they are really valuable tools and just finding other electronic ways to communicate to people, you know, using things like our EELIS that happens here in Exmouth. [So were some of those ideas sort of germinated in a reference group, or…?] Possibly some were but not all, possibly some were, but it just gets people thinking about that, you know, because if you had an insular reference group that was totally focused on the science, they wouldn’t even care if they were reaching anyone else’s ears. It wouldn’t be important to them. So by talking about it and bringing community groups like the Shire into that sort of environment, it then creates that realisation that yes, yes, we need to find ways to get to everyone.

5.3.2 Sharing responsibility for getting information out

- [And the nature of the reference group’s discussions; did that influence your thoughts?] I think I guess the informal nature of the discussions and the open nature was good, there was no hidden agendas there and I guess from my point of view I started to have a realisation that okay this isn’t actually something that we have to do. Traditionally, I would imagine it would have been seen as a DEC role to roll out all this research and I naturally assumed that that was our role and that perhaps I could have been defensive in terms of oh, what are these other people coming in trying to do this and I saw that we had a position in Perth that was bringing out this information and I thought well, there’s some conflict there. But over time just based on those discussions and the interest that was shown, I started to realise oh, perhaps there’s a better way of doing things and this was one of those better ways of doing things and sharing the load around and taking away from that DEC control type position.

- It’s a big change for a department like us to have a different approach to how information about the marine environment is disseminated ‘cause I think we’ve seen that as probably our responsibility. Because we manage it, I’ve seen it as our responsibility to get that information out. I’m now aware that that’s not the case and from our point of view it’s advantageous for us to try and disperse that responsibility ‘cause not only does to reduce the pressure on our resources, but it also increases the
ownership of everybody else of that information as well. It’s not just DEC telling us, it’s I’m actually involved, I understand, I own the stuff and I appreciate it for what it’s worth as opposed to I’m being told.

- ...it was definitely good that it wasn’t just DEC running it and by no means am I suggesting that DEC should have been the agency running that reference group, I think that would have been the worst thing that could have happened. I think having it removed from what we were doing, even though a lot of it happens within the marine park that we manage, I think to me that proved a point that there’s other ways to go about these things and we don’t have to do it all so to speak.

5.4 Conducting science and research

5.4.1 The role of science has to change

- I think that a lot of the problems with natural resource management, the push back they’re getting in particular in the climate space, is down to some ways that the scientists were taught, both my generation, the previous generation, but I think even today’s current generation, the way that we’re taught how science works in university and what the role of science in society is (i.e. impart the information and then leave others to interpret and act on it as if it were a decree), if it was ever true it’s no longer true, I’m not sure what’s behind that, or whether it ever really worked the way that we’ve been taught. But it’s certainly not the way that it works now. Our science has to go in a very different way if we’re to continue to have a role and not just be marginalised.

- And the increasing pressure within society to treat science as if it’s some faith-based thing that doesn’t hold true, that if people don’t believe in evolution its not there. Or that you can magically change the laws of gravity just by saying physics is wrong. It sounds odd to a scientist that people can think that way but there’s an increasing percentage of the population that does, who don’t have an appreciation, for instance the whole conspiracy that climate change science is there because scientists want the money. If people really understood what science was about and what motivated scientists, I’m sure that there are some fraudulent scientists out there, but science isn’t about money. They’d know that if they knew anything about science...And if they knew the criticism, the critiquing that we have to go through, I think there’d be a greater appreciation on the community’s part, but equally on the scientists part they’ve got to appreciate that if we were ever held up as these gods that when we spoke people listened and accepted what we said, then that world is certainly long gone. I’m not sure it ever really held up. I think it was a myth that grew out of the early 20th Century, and it’s just that it’s being driven home more that that’s not true now, and the scientists need to change the way they’ve been communicating. Getting that across is proving to be difficult particularly in some fields, as much in the social science field ironically as anywhere else. But it’s certainly something that we want to do because we’ve seen how to do it right and how to do it wrong, and after northwest shelf hardly anyone wanted to talk to us, they thought we hadn’t answered any of their questions and were completely useless. But actually we’d answered all of the questions that have come up there in the five/six years since, but no-one’s read the reports, no-one’s gone through the model outputs and they’ve made all the mistakes that we warned against.

- Whereas my anticipation and my hope is that with the greater degree of interaction that we’ve had around Ningaloo, but I’m sure some mistakes will still happen, that all of the lessons won’t be appreciated, but at least I’m hoping that at least some of the ways -and it looks like already - that some of the ways they think about the system have changed, they’re asking more informed questions. So if the world wants to put a large number of oil rigs up on Ningaloo the lifestyle will be changed considerably, but if people make that decision in an informed sense without just letting it rollover the top of them, then I think we’ve done a much better job.

5.4.2 Invest in Interpreting science

- [So when you said science needs to change the way it goes about things; how so in your opinion?] In the past, just generalising, I’m sure this isn’t true for every scientist, but it was certainly the way that I
was brought up, the thinking was that you did your science, you’re as objective as you possibly can be, you didn’t interact, you just said ‘right, here’s your answer, you go do with it what you will, I’m not changing it’, it was sort of an announcement from on high effectively. And that somehow that would be just taken up and used. And if it was ever true, like I said, I don’t think that’s true anymore, there has to be a greater appreciation of the fact that people don’t interpret information the way that you mean. So even with your best of intentions, just by handing off a spaghetti diagram, you’re probably not even telling them what you think you’re telling them, so you have to have a greater interaction with people – not necessarily to try and indoctrinate them with your view but at least to inform them on what you’re really trying to say. They still need to take information themselves and use it as a part of their decision-making process so science needs to appreciate that we need to stand up more, not as an advocate but just to make sure that the science facts are clearly understood. They’re not to try and say we want this social outcome, but just to say here are the science facts, let me help you understand them and interpret them and then you can still make your own decision.

- We don’t want to go to social engineering but we do need to appreciate people don’t understand science as well as we think they do. They certainly don’t understand the way that we’ve been trained to communicate information, so what looks like a standard time series plot with error bars to us or a standard flow diagram is either incomprehensible to the average person or is quite easily misunderstood. They need to be much more clear about how we do that, so we have to engage more with people just in communicating that.

**5.4.3 Need for adaptive/flexible approaches**

- … it was interesting for me because it made me realise that if you’re a modeller coming into these situations you need to be very flexible. In terms of even the model structure you’ve got to be able to address new concerns as they arise, because at the start of the project you might have no idea what people will be asking for in 18 months’ time, it could be something completely different.

**5.4.4 Focus on what people need and want**

- We also have to be less impressed with our own facts, so not having PowerPoint slides with 30 very finely typed dot points on them. Add a couple of big cartoons, don’t patronise people, you don’t have to do that, but you have to make it easily understood. You have to make it easier to rapidly understand because people don’t have a lot of these days to understand what you’re trying to tell them. And it might have been four years of your life to find out this fact; you don’t have to lead them down the whole four years, so just get to the point. If they want more details, they’ll ask. So be ready with the details if they want it, don’t dumb stuff down, but you have to re-focus on what the other people actually need and want, not what you’ve lived through. So take yourself out of the science. There’s probably another lesson that we’ve learnt more this time around I think. That’s also a lesson that scientists need. They’re not completely objective automatons, we do have our own subjective contributions and part of that is that it does come to dominate our lives so much that we forget that other people don’t live it, and that they either aren’t as interested as we are or don’t understand the intricacy, so we have to spell it out much more clearly in a way that’s actually going to show the relevance to them.

**5.4.5 Attitudes and communication**

- Yes. I think, like I said, at least some of the ideas I was already beginning to have but in many cases it either firmed them up, or took me in a new direction. Certainly all the modelling of how people think and attitudes and their social and their perceptual and attitudinal dimensions, of the work I’ve done, I’d only done a tiny, tiny bit before that and it was kind of like, oh is it worth it, but here it was definitely critical and certainly shifted to become a major part of the work that I do. It certainly changed the way that I try to communicate with people and interact with people. It’s changed my perception of how
information is stored and relayed and how reliable an image in the past can it be, so written documents versus verbal communication and that kind of stuff.

5.4.6 Valuing anecdotal and local information

• [Ok. And some of these reflections, are they as a result of this project or were they things that the scientists already knew or…?] There were some things which were things I was already thinking about and saying before, but this certainly solidified them. I think some things were a realisation that came out of this process. I think it was a kernel of an idea that had been growing for a long time, that the whole idea of anecdotal information… You do have to be incredibly careful about anecdotal information and stuff that you haven’t independently verified. That warning has obviously grown up from someone being very badly burnt at some point. So you do need to be careful about that, but science has gone a long way to throwing the baby out with the bathwater and ignoring the fact that people that live in a system, they don’t have a perfect understanding of it, they don’t always have a complete understanding of it but they have a better understanding than someone that lives on the other side of the planet or on the other side of the nation.

• There has to be a greater appreciation and a use of local knowledge so better methods. Some of that Fabio and co have certainly been working on, better methods of eliciting information, lifting information out of those discussions, so not being led astray by things that can’t be verified or things that might be due to a perceptual mishap. But finding the true nuggets that do sit in that local perspective or that information. So whether it’s a fisherman or a tourist operator or whoever, they’re out there everyday, they see the animals interacting with each other, they see the changes through time. So some of that can be coloured, we do tend to have a biased way of remembering things, we tend to remember a big fish much more than we remember little fish and stuff like that. But you can still, using fuzzy logic and a whole bunch of other methods, get useful information out of that. So having people up there that have lived through decades of the system and seen how it’s changed, we don’t have any other information source like that, so to completely disallow that kind of information just because it wasn’t collected with a quadrilateral ruler is pretty short-sighted I think.

5.4.7 World views and incentive structures

• By working with such a large number of people up there, it’s also helped to…we haven’t formally written this down, we certainly haven’t had a peer review, we haven’t gone through literature, but we’ve started to sketch out a mathematical idea of how people perceive the world, how to classify the different incentive structures and pressures on them. And so far it seems to capture people pretty well. If that really is something that’s true, then that’s going to be an enormous breakthrough, it will most definitely lead us down some blind allies and lead to some new mistakes, but it’s going to get around some of the problems in the past where people made well-intentioned management decisions without thinking about what incentive structures they were really setting up for people and how…what they thought they were doing was at odds with what they were really doing.

5.4.8 Learning from other disciplines

• And all of us working together has influenced how we’ve worked in different ways. I think probably Beth learnt a bit from me because I’ve got a very personal approach with people, and I think she took that away, whereas she might have had a more scientific approach previously. It probably came out of my background in social sciences with the way you do research in Indonesian studies, it’s like that, it’s much more influenced by anthropology.
5.5 About research and the NRP

5.5.1 More awareness about research

- It’s been positive really. Making sure that the information and the community are aware of each other has made a huge difference to people and how they see researchers for starters. People were often not aware what was going on and it created a ‘them and us’ kind of scenario, and that’s been really valuable, people are now aware there’s research out going on. It’ll be even more valuable when there’s concrete results. In the general public I don’t know how much awareness there is of the website, [So, your sense is, around town that there’s more awareness about what the research…] There’s probably not as much awareness as there could be, but depends on each individual’s level of interest. There’s certainly the awareness to the point that people know there’s been people up here doing research.

5.5.2 Attitudes towards models

- [And what do you think people’s attitudes towards the models themselves are?] Depends on who you talk to – people who have been to an intensive training and understand them tend to be more open and receptive to them. Talking to general people in the community they’re still quite sceptical on what information has been used.

5.5.3 Barriers between scientists and community

- And do you think people’s attitudes towards science or scientists has changed at all as a result of the presentations etc? Oh, I think they have more of an understanding of what scientists do in the community. I still think, there’s always going to be that barrier unfortunately and I think that comes about from mainly, it’s just that academic level. People look at a scientist and go well, you’re bright and you’re all this, but what are you actually going to teach me or what am I going to learn from you? Yeah. What am I going to get from you? And it gets back to that layman thing too.

5.6 Management of the region

5.6.1 More open to environmental concerns/issues

- Council is involved on an individual basis to attend certain meetings and do some training. I didn’t see that four years ago. It is by getting the researchers here and inviting Council and the CEO and staff to be part of a modelling workshop or a presentation or something like that. I think that has worked within our organisation to open our eyes a little bit. [Although that hasn’t let to uptake of the model per se…] No. But, it has opened up the minds and the thought processes that it is an aspect that we might have to spend a bit more thinking and time on.

- [In what way do you think?] Well, it wouldn’t be ‘save the whale’, but simple things that we can do within the community that are within our responsibility, such as being a bit more aware of the implications of what we do, look after the place a bit more. We just had a session yesterday with senior staff on our new strategic community plan which is the Council’s ten year plan, so it’s all high level statements but there are some pretty strong ones coming out of there in terms of the environment that we want, it sounds very ambitious, but we want to be the leader in WA when it comes to being a sustainable community, whatever that is. We’re not getting into the detailed actions yet, but we could look at alternative sources of energy, recycling. So, some of these statements, you see them a bit stronger now in this new strategic plan than in the one that was produced four years ago. Again, it’s just talking to people and listening and getting some more ideas. [So, indirectly an influence with all these scientists?] Oh, definitely yeah. I think so, yeah.
5.6.2 World Heritage

• [Was your view on World Heritage in any way influenced by the research program and the stuff that happened with that?] Oh, definitely. Because a lot of the stuff that I’ve now been privy to through the researchers, that I’ve read and looked at, I knew nothing about any of those things. So, to me you’re enlightened by being shown these things. [So, stuff about the marine environment, about tourists and that range of things?] That range of things and, as I said before, I didn’t know a lot, I mean I knew a little bit but not a lot about that. Having been shown just made me think more about protecting it.

5.6.3 Change and the future

• Oh, definitely, tenfold Kelly, tenfold. I’m sure I am one of many people that have had their eyes opened and their minds opened up to what actually is going on in the community, where the community could be going and I think what you’ve done is give, for me anyway, is given me another way of looking at things. Because I think most people, and maybe I’m wrong, grew up with in a town like this thinking there’s nothing wrong or nothing happening out there because it’s just a day by day. I can go for a swim, I can hop in my car, I can go for a swim when I want to, I can go and drop a line in the water, I can go and shoot a fish or whatever. So, with that attitude, life’s great. What’s happening? There’s nothing happening here. But really the underlying current is there’s a lot happening and without people like you that come and live in our community and actually get involved with the community, a lot of people, I certainly wouldn’t be aware of, I am aware of a lot of things but not aware of a lot of things…[Do you mean the sort of pressures and the change…] Yeah.

5.6.4 Tourism

• [Do you mean the sort of pressures and the change…] Yeah. The change and having the tourist cycle and things like that explained to you. Because, even though I’m like you, I’ve been all over the world, I looked at tourism in a different light when I was away, I looked at how can I improve tourism back in my community and what’s the difference over here, what makes this work and why it doesn’t work here. It’s probably pig-headedness more than anything else unfortunately. We are still very backward
in the way we look after tourism and that’s why one day, hopefully, if I ever had my own licence and that, it would be done so totally different. It would be done the old school. And the boat will be available for research, that’s one of the big things.

5.6.5 Adaptive management

- It certainly reinforced that theme of adaptive management and needing to use the information for what we do on a day-to-day basis. [Ok. So, using the information to influence your practice?] I still haven’t got access to all the information but in theory, that’s, it shows, and certainly Todd and Beth reinforce that adaptive management stuff quite a few times and certainly thought that was very valuable. Yeah. That message really got through, it’s good.
6 What are your overall thoughts on how the process went? Next steps?

6.1 Communicating research results

6.1.1 General

- I think, like I said, it’s good that, whether it worked or not, it was good that they tried to get the information back into the community. Whether it worked or not, I’m not sure, but it doesn’t happen enough and that’s what I keep telling other researchers and the oil and gas companies. I say you tell us every time that you support this and this and this and we never hear about it so, can you ask your researchers to come to the community and show us some of the results. So, I think they should be commended for making that effort. Yeah, definitely.

- I think, certainly compared to other projects that I’ve heard about and been involved with, we did quite a good job in getting the information out there and getting people’s heads around what it was and what it meant and demonstrating how it could be related to questions that were important and real.

- [Was there anything that you thought didn’t work or could have been done better?] Oh, well… I don’t know, nothing is springing to mind. I mean, I’m sure no matter what we do we can always do it better. But something’s better than nothing. So yeah, I don’t know, nothing sort of springs to mind in response to that really.

- It’s certainly raised our awareness and I think that’s probably half the battle is just making sure that we’re aware of what’s out there so that we can access it if we need it. [As an agency?] Yep. But I don’t think it’s been handled, well I wouldn’t say not handled well, I don’t think it’s been done as well as it could, but I’ve got no solutions as to how you can get it done better. Because it just disappears into everyone’s busy and everyone’s priorities change and all the best intentions don’t necessarily flow out. Somehow you’ve got to have one person who’s doing nothing but pushing that one barrow to keep it rolling along I think and resourcing for that is always going to be a hard thing. You’ve always got to balance up what you resource and where you put your money and where you put the people and, yeah, I guess we’re just not in that position to do that at the moment.

6.1.2 NRP website

- [Have you been checking the website by the way to see what’s up there?] No. [Because reports are coming out and they are on the website as they’re completed.] I guess Kelly that one point is we’re skeleton staffed and resourced and just do not have the time or opportunity… I don’t have ten minutes in a day to go cruising through websites. When our turtle data becomes available once per year, we have a key distribution list and let people know it’s come out. Of course we post it on our website, but if I relied on that, nobody would know it’s available. Because everybody is that busy. [So that would maybe be a suggestion on your part?] If something becomes available and it’s a big thing whether it’s once per year or once every three years or five years, just send an email out to say its available, here’s the link, contact this person if you want more information. That’s all that’s required and we can take that and run. I’ve had contact with other people, not to do with the Ningaloo research stuff but other stuff, where they say just keep checking our website. If I had to check everybody’s website for all…for example, for grants that become available, we just can’t do it.

- I’ve had a look at the website as well and currently it’s limited, but there is some information on there. Some researchers put quite specific things on there, but others, obviously at this stage their research hasn’t resulted in a specific finding, so it’s more vague or suggestive information.
• On the website there wasn’t a lot of access to how to contact the researchers. So, it was hard to see what projects aren’t in there, what projects have happened and have not been put in there and how do you contact those people because you don’t even know what projects are not included. Because some researchers have been really diligent and they have put in their stuff and that’s great, but it’s like the presenters, it’s the same people that come up all the time, but there’s all these other people that you’re not really aware of and I don’t know how you access them.

• The website will be valuable as more information goes on it, because it’s a central spot to go.

6.1.3 Ningaloo Atlas

• [Have you looked at the Ningaloo atlas?] I have been in contact with them, but I haven’t looked at it yet. Yeah. I’ve given some of our turtle data to them as well. Stuff like that is excellent. Any central point where you can access all the different types of research findings or available data on Ningaloo. [All the stuff from the Ningaloo Research Program is going on that atlas, is my understanding.] I think that is going to be great.

• There was a guy at the Whale Shark festival who was with the Ningaloo Atlas, it’s a website they’re setting up or they’ve set up for all the scientists…When I did have a look through the website and looked into a couple of links… I don’t know if they just started to set it up but I got a bit disappointed that it wasn’t the information that I was looking for. I was given the impression, go there and we’ve put the research in layman’s terms. So if they work on that a bit more ‘cause obviously that’s the idea, some of that research would be put into basic information summary sheets.

6.1.4 Media campaign outside the region

• The other thing we’ve got to remember here is that’s it not just about engagement in the region. We also did that interactive website and that involved a media campaign focusing on politicians and business leaders as well as bureaucrats. So we weren’t just going from bottom up, we were trying top-down as well, we got a liberal politician engaged with it, showed him what was going on. So we had a really full-on go at it but it [model uptake] was still somehow [not as effective as we would have liked]…yeah, it’s tough to say.

6.1.5 Presentations

• Yes -research certainly appears to be more available. I’ve seen some public talks advertised locally through eelis and on the notice board certainly not the whole cluster’s work, but there’s been information from a few key ones. I’ve been to a couple of the public talks and, I did learn from them.

• All the scientific presentations and just the, or normal presentations, they put a lot more input into the community and it’s got people talking. Are they good for the community? I think they are, I think they are. When scientists come into town I would like, some of us, would always like to get the chance to share with them, ‘cause it’s only just started to happen really, in the last couple of years and I think a lot of that has to do with people like yourself that come in and share their knowledge and bring other scientists. Because normally we don’t get to share anything, especially having seminars like that. So, that’s a great thing and I think given the chance more people in the community will go to those things, whereas if they’re once in a blue moon or if it’s at a level where people don’t understand, they won’t attend.

• [So, does the scientists having a presentation at the Fishing Club count?] Yeah, that does, that does. But, that’s a start and I thought that was a wonderful thing. That’s the first one of those I think I’ve ever been to in Exmouth. [Ok. Did you think that was a good format that they did there?] Yeah, really good. I don’t know necessarily if the place is right, but I liked the way it was done… and the beauty that you could talk to people after, you could talk to people… You could actually speak to the people that were involved in it after and that in itself is a winner just there. If you can go to a presentation, any
presentation and the presentation’s been given by the person that is actually involved in it and then you get the opportunity after to speak to those people, to me that just adds credits to what they’ve actually done. Instead of somebody coming along and going look I don’t know because I didn’t really do the work, I’m just a presenter. To me, for me anyway, the pleasure about that was these are the people that are involved in the research. So, if we wanted to ask questions after we could, just in normal conversation, you feel like you’re talking to somebody that knows what they’re talking about, because they were involved in the research or in the program.

- Presentations and informal, both. It’s to gather round, have a barbecue and invite people, have it on a big screen at somebody’s house, like an informal thing but formal to a point were you could have a barbecue and the scientists are there and then you have a big screen; alright guys, this is what we’re doing, this is this program. Me, personally, I just don’t think the information highway is enough. We don’t get enough information. And I think that that people, not so much that they want to sit and read and read and read, but they need some information.

6.1.5.1 Backyard presentations

- And I think some of the talks and spiels that we have, even that one that we went to up at the game fishing club, I really enjoyed that but I think the format of that was very wrong. It’s like here we are chairs all in a row, somebody out the front. To me, you get too much movement. See how many people were getting up and down, up and down, you don’t want that…[So, what would you do differently?] Well, I would have had that in somebody’s backyard. Put it in somebody’s backyard straight away, it’s not hard. These people will give up that time, have it in their backyard. And all of a sudden, when you’ve had one, people go ‘oh, I went to a meeting last night, it was great.’ Well, ‘what was going on?’ ‘oh, they’re just showing us this and that, it was in the backyard it was great.’ So, next time we have it and the word gets out, people are going oh, I think I’ll go to that, they said that was good and it was information, da-da-da and not only that you’re talking with these people on a different level all of a sudden because you’re not sitting in a seat going like this. Now, when you give a talk like that when people have got to put their hand up, that does me cold straight away.

6.1.5.2 Avoid classroom style presentations

- [It’d would be more of a mingling and not presentations or?] No, no. They can still give their presentation but it’s just your mingling around and then there’s people…yeah, ok, well look so and so’s going to talk for the next five or ten minutes guys so, if you could just give your bit of attention and they’ll be seats around, they can sit down, they can stand up, they don’t…but it’s not that real formal classroom stuff where people, they get fidgety after a while and they get up and they get down and there’s all this movement and you’ve got people walking and ducking and it’s like…argh. There’s nothing more frustrating, especially if you’ve got somebody out there trying to get their message across. And all they can see is people…movement going across their eyes…if you can avoid some of that. I got taught a long time ago when you’re giving a talk, never sit people down in circles and squares and rectangles and that, because you get all this negative feedback and it really does happen. You do get negative feedback from people ‘cause after about five minutes, the fidgeters come in and the coughers start…Just let people be themselves out there and then you can get the message across.

6.1.5.3 Use a speaker for presentations

- For a start, that lady who couldn’t hear anything. Unless you sat where you were or out the back, half those people couldn’t hear so there’s that…so, you get somebody with a headpiece, stick it on them, you have your things out the back so that they can hear everything that’s going on. Yeah. So, they actually speak into a speaker, where it’s plain and easy to hear, nobody has to keep yelling out I can’t hear you up the back or the back rows lose interest, they just sit there like that. And people do that at meetings. I’m sure you’ve been to enough meetings to know.
• Like that meeting at the fishing club, you could've pushed that out into the court way and had a microphone and speaker and it would have made a world of difference, world of difference 'cause then you're giving people the choice if they're going to walk, they don't have to walk in front of the speaker, they could walk out to the side. It's annoying enough anyway but to have people walking across and ducking down and you're sitting that close to each other that's uncomfortable in itself 'cause people will come and think oh, I'm not sitting there, I'm not sitting there. So, straight away, you're going through all that in a meeting. There's a lot more involved than a lot of people realise. The dynamics of groups. It's quite funny, I'm a huge observer of those sort of things so, I always sit back and watch, which teaches me things about people and how you run things to make it successful.

6.1.5.4 Make presentations/meetings more interactive/interesting

• [How do you make a meeting interesting?] Like question and answer time, why quiz things like who thinks they know how many fish were killed or what...those type of things, get people involved in what they're actually doing up there. [That's hard for scientists because they're not trained to deliver it like that. There are people who do that for a living]. Well, I think it's a combination of if they want to get their message across then learn to combine the two. They're dealing with layman, so how do I keep a layman interested? Ok, not only do I have to give him information but I've got to somehow get him to show that he or she's actually interested. So, pop little questions in here every now and then, not rocket science questions, something that he pretty well knows they're not going to know anyway, but they're going to have a stab at it. [Just to get a bit of interaction?] Yeah. Because then they feel like they're involved. You don't have to go no you're wrong you dumbass, you can say, well you weren't far away that's pretty close, we're about around at that figure so then people feel a bit chuffed about themselves so that all of a sudden you get that involvement.

6.1.6 Final research reports and summaries

• [So, what about handing over reports...] Not just hand out reports... maybe it's some of that, but, we don't have handouts, we don't have those type of meetings that we had up there very often.

• [Well, they're working on all the summaries for the research, they're looking at three to ten page summaries of all the research projects, those will be finished supposedly in November and then they'll be loading all those up on the website. Now, how user friendly they're going to be, it's going to be a tough balance...And I think that's the hardest thing because you've got scientists who are writing papers, not for the everyday person who just wants to learn basics. I mean, if I was in their position I wouldn't be wanting to be writing my paper plus another one].

• Like for me, I'd like to know what did they actually research, very basic, you know, how long were they here for, what period, was it once a week over a year or was it they were just here for two weeks or, you know, very specific that way. Because obviously they're only here in the water or here for two days, it's only a very small window.

6.1.7 Ningaloo Research Centre

• So I think the Ningaloo Centre, it's going to be a real pivotal point for this town and for region...our intent is to build a building that draws people so people will be attracted to the building and then in there they'll discover this wealth of information and interaction and just very naturally will and very enjoyably (hopefully) will discover so much about the region and this place and sense of place and what people appreciate. That's the intent.
• Hopefully things like the research centre will go a long way to getting that information out there.

6.1.8 Information transfer to non-government land managers & operators

• The glaring omission, and maybe they’re still getting to it once they’ve completed their projects, there’s got to be an information transfer back down to the land managers by the researchers. They shouldn’t just feed out the research results and findings to government agencies but also to non-government landholders, managers, stakeholders and tourism operators who manage and influence public visitation on the ground. We need to know what the findings were … not so much the social research, for example public use patterns etc, but first and foremost the biological and biophysical information. Why is this area important? What are the key parameters? What influences change? What did your research find and why does it matter? It could be a 1 – 2 year program to get the key information out on the ground, to tourism managers on the ground, but also to the general public. Otherwise the new knowledge and information will just sit in university libraries, or many PhD candidates or people who already have doctorates will have more information in their heads and a few more will become doctors and that’s the sum total of the value of it, which would be a great shame and loss to the protection of the Ningaloo coast.

• [And so that information sitting on a website isn’t really sufficient?] No. Everybody is so busy, everybody is under pressure to cracking point with the amount of workload they’re carrying. It’s not good enough because it’s not only your website or the next one’s website or 20 others, there’s 50 a day that I could have a look at if I had the time. Because we’re under so much work strain, we can only deal with priorities. When something is flagged to us as significant or important, we will find the time to look at it. We don’t want to be flooded every day with 20 e-mails about studies coming out, but say once a year, summarise, group the key findings together where it may affect management on the ground… we will make that a priority, we will bump something else to be able to get to that.

• I think it’s critical… if we can inform the landholders and tourism managers about the Ningaloo Cluster research findings, that will change behaviour on the ground.

6.1.9 Whale Shark Festival

• [I wanted to ask you about the Whale Shark Festival with research results being presented …] Yeah. I missed that. [In dealing with the community and with the Shire afterwards, did you get any sense that the information travelled in the community at all?] I’m not sure. [Or did you get any feedback from people about how the presentations went or how they were received?] More from people who attended, yeah, and they all enjoyed it. I’m not the person to ask because I wasn’t here for the Whale Shark Festival and I know there was, in general, good feedback on everything that happened at the Whale Shark Festival, not just the bands but they liked the presentations and the market set up that was there. But specifically on what was done here, I’m not sure. That would be a question for [the research coordinator] or someone else who was there. [Yeah. I was just wondering if you’d had any feedback on how people heard about the research and if they had any interest in it.] No.

• The Whale Shark Festival worked, it was definitely well received. I think that some of the community presentations were quite well attended.

• Oh, I got a lot out of the presentation and I can’t remember his name but he’s the one that does the fish tagging. He’s had a few slides and they actually showed how they tag a fish and I think they’ve timed it at about 45 seconds or something, to have them out of the water, and I found out that they do this testing, there’s all these receivers down at Mangrove Bay, so that information that he gave in his little talk was really relevant for me, to know just some of the basic information. There are certain fish that are usually on the outside of the reef but when they tagged them they found that they stayed in for most of the month and then only went out on these days, where really they should’ve been out by this time. So things like that, the really basic information, I am just looking for really basic information.
6.1.10 Ningaloo symposium

- But there was a symposium, a Ningaloo Research Symposium in Exmouth, early 2009, that was outstanding. My knowledge increased a thousand fold as a result of those two or three days there, but unfortunately there wasn’t anything like that again. That was April 2009.

6.1.11 Delays/lack of concrete information

- As I said, unfortunately, a lot of the projects haven’t been finalised so there’s not a lot to actually take back and share yet. And that’s the same with the website, there’s some stuff on there but there’s not hard concrete information and that’s the nature of research it take ages to do your PhD and finish it off and publish. [There should more reports be finalised in November]. Those sorts of things will probably add a lot more value to it.

- I think it will be more valuable to get information to the community once you have concrete information, because its hard to appreciate something that’s not really finished. The feedback I hear is like yeah, but they don’t know yet, why do they bother telling me about that if they don’t know what the result is. General community people like hard evidence.

- I would like to think that, just because there’s so much research goes on in the community, it’d be nice for some of the research to ebb and flow but we don’t get that ebb and flow and I know it takes a long time for scientists when they leave to write up what they were doing, their jobs and that. But, it takes too long. There’s just far too many months or years go between research and information.

- If you’re going to come into a town and do a little research thing or a scientific thing, you already know your agenda when you’re going to come here. My belief is the scientists know their agenda before they even start, and you know how I feel about DEC doing the same thing, they should write-up something straight away -even before they start doing their research, and then when they do their research, and when they’re finished- they could just do a short summary of their schedule of what they’re going to be doing when they’re here. And when they’ve finished, they can provide another summary of, well we did this over the last month, we were very successful in being able to do this, this and this and these are…and just a short summary so people go oh, ok, so that’s what they…now I understand what they were doing here.

- ’Cause they know it’s going to be a year or even two years before they really get the nitty gritty of what they were actually doing. So, by then people look at it and go, well what’s the point of that? Because we’ve come two years down the track so things have changed in that cycle. Let’s say they researched a certain coral in a certain area on the reef. Well, in two years time, we know the cycle of life is going to go completely around again in that piece of coral. [So, things could have changed…]Dramatically. So the research is no longer really valid for that section of reef and that’s the way people look at things like the fish quotas and the amount of fish that live in this area. People look at it and go ok, well that’s two years ago, so where are we now? We’re always behind with it. But, it’s trying to get the layman to understand that’s how research works. It can’t be can’t be just we’ll go out and look at the reef, come in, write a summary, there you go, that’s what’s going on out there. Can’t happen in a month, can’t happen in a week. But, to have a small thing about here’s the agenda, this is what we will be doing, and when they’re finished, we were successful in being able to do this, this and this. So, people that are genuinely interested become more interested and go, ok, well that’s good. So its not two years later that you’re trying to ring their bell to remind them, remember when we were here two years ago doing this? Well, I don’t remember it.

6.1.12 Reduce lag times between research and putting out information

- Just the things that I would like to see, more things come to fruition quicker. And I’m not saying…whatever they’re going to do, it would be just nice to be given more information on it. [So, if you could make a suggestion about improving the process, that would be it?] That would be one of them, yeah.
• I just think one of the big problems we suffer here is lack of information. It really is, it’s like you take the whale shark industry, I mean, I’m probably getting a bit off what you really want, but it’s that information highway. The whale shark season has been closed down now for three or four weeks. How much longer are we going to wait before we can get some information about what went on in the whale shark industry this year. It probably won’t happen for another six or eight months which I think is ridiculous. [So, the slow feedback is a big issue for you?] Yeah. Slow feedback and sometimes no feedback. I just think that we, I haven’t got the answer, I just think that information for me is how you sell anything in life. Without information, people don’t know. So, yeah, like the community board down town, a big one.

6.1.13 Availability of results
• [Do you feel like you have reasonable access to the information from the research?] Not as good as we should. I think that’s, once again, it’s a bit like the model, it’s all, it’s been talked about nicely and how it needs to get out there and how the research centre needs to be developed and…but you still, you can’t actually see any, apart from a few of the seminars that were organised which were fantastic, you still don’t see, well I don’t see any more than I would have necessarily had access to anyway I guess but I’m in a relatively fortunate position in that regard.

6.1.14 Leave something behind for community
• Relate to the people who don’t understand. Make an agenda about what you’re going to do, as I said before, and then when you’re finished leave something in the community so the people that are genuinely interested in the community, that can pass it on too.
• To me, its one of the problems I’ve always had with DEC, I believe that there’s 35 DEC officers in this community and I believe and I always have done, they don’t do enough in the community itself. I’m not saying they don’t do anything for the community; they don’t do enough in the community. …Show videos and things in the community. Have them so DEC are running them in their office…I mean you walk into the DEC office, there’s not even a TV running.
• I believe that most people are people that are layman are more approachable if they’re shown things, get to read things. As much as I hate to say this, a lot of people, I think, in this world today that we live in, they’re very closed minded, they’re very shut off from the…why should I be concerned. Because they’re not given the information.. Don’t just go out there and do the research and then take off.

6.1.15 Role of relationships in sharing info
• [You can give the lay people information, but do you think it’s important to first have some sort of relationship with them or…?] Well, yeah, probably. But, sometimes that’s not going to work, sometimes maybe giving information and then coming in after can work. I’m not sure, I think you’d probably have to look at both ways to try and find a happy medium there. But I know from my own personal point of view that meeting somebody like yourself who has this information and then is prepared to share it, it’s so much easier to understand and it’s so much easier to feel good about yourself and how you are now starting to believe in the things that you’ve been shown and taught. And that just comes about from knowing somebody that knows what they’re talking about, up to a point.

• [Well, what if I put a notice out and stood at the Hall at the Shire saying did you know blah, blah …do you think that that has the same effect as sitting around sharing information in a social setting?] I think it, I don’t know, that’s a hard one. I think it can, but I think the only way that can work, presenting information at the Shire hall, is you to be known in the community, yeah. I I think, especially when you’re trying to get across some of the messages that some of these scientists are trying to get across, I think it’s very hard not being known in the community. And I think what they should do is really seek support sometimes with people, not so much me, but people like me, when they want to present these
things. And how about sitting up at the table with me because people are going to see you there. That type of thing.

6.1.16 Credibility issues

- There was one project that unfortunately was one of the ones presented publicly that really caused a lot of scepticism amongst locals which was a shame because it did devalue the legitimacy of the other projects. The one about crayfish that said there’s only a couple of crayfish caught in this huge area, I can’t remember the exact figures, but it was some tiny amount of crayfish in comparison to historical records of...and because the talks were about fish, there were quite a few fishermen present and having done crayfishing themselves, were very sceptical about those results.

6.1.17 DEC should do more community outreach

- I don’t know why DEC don’t run programs every now and then, I don’t know why they don’t run a television screen in their office down there. You go down there and sometimes you can’t even get any brochures, it’s got office copy only. This is our DEC office and you can’t get what you need here, so where do you get your information from? Where does it come from? And I don’t think…and I’m not knocking them, I’m not having a go at the people there, it’s just the system I think. It’s probably the system, it’s a government thing but I still believe that we can all hide behind that. It’s easy to say it’s government and this is the way it works. Well, a little bit of forward thinking, you’re living in a community 2,500 people, let’s do something for the community. [So, they should reach out more?] Definitely. And people don’t look at them in the light that they used to look at them. There’s still quite a bit of unhealthy feeling about DEC in town. Sometimes I have trouble trying to explain or understand why, but then I think that it’s something that’s down through the ages. But, you’d like to think that it should be finishing but if DEC hide away like they do and don’t come out and show us. I mean they say that they’ll have a stand at the Whale Shark Festival, that’s ok, that’s once a year. Do something else. Get involved down town, help with the community board, stick your own thing up there, have photos, have programs. Just information.

6.1.18 Get information to others beside DEC

- If you only get information to a small group and it’s kept to them, like the meeting we went to up there I noticed there were a lot of conservation and land management people, DEC people there, which is good, that’s one level of the community, but you need to you need to go to the next level. [How do you get to those other people?] Well, information and I keep telling everybody and nobody listens to me, it’s information. [But, information how?] Well, through DEC. I still believe that they do the wrong thing by not having something every now and then down in the Shire Hall. I think the scientists, from the different universities, they all come here and do certain things but do they bother sharing it with us? No, they don’t.

6.1.19 Informal get togethers

- [And do you think the opportunities you had like that, to go to Whalers with the scientists, or when the scientists came here to your house, do you think that that, do you think that had an impact on you?] Yeah. It has an impact on me because you find out they’re just normal people. They’re different because they’re academics, but they’re just normal people and they’re prepared to share. At least those people were. And it was a good night at Whaler’s because you could talk about anything and everything. The important thing is that this community, with the amount of infrastructure in the community as far as the land and the sea base goes, we need to have more of those things. We really do.
6.1.20 Notice board

- [So, how do you...you just said people don't want to read, so when you say get information, do you want information in terms of paper or websites or do you want personal contact?] Personal contact, website. I still believe there should be a big community board down town, absolutely, and I have always done it. A board that’s got no ‘for sale’ or anything, it’s just got DEC, scientists, for example, these Edith Cowan scientists will be here over the next three weeks because... then people go, ‘oh, I wonder what they’re doing’ and then if they read down a bit further they’ll find out what they’re doing. And, if they've got time to give us, on 03 December the scientists will be giving us a talk on...I realise not all of them can do that because of their time, but I still believe that the community... [So, sort of like a noticeboard like CCG has?] Yeah. But a big one with the west coast and the east coast and the oil rigs put on it, everything, so people look at that and go ‘what's going on here?’ It’s an awareness thing, it's like anything in life, if you want somebody to do something or to buy something, you make them aware of it, you show them.

6.1.21 World Heritage

- And I think World Heritage will probably help with that as we start to get more resources and people associated with management of the World Heritage area we’ll be keen to turn that into developing it more in terms of information for the community and the public and those sorts of things. But, they take, as you know from Shark Bay, they take years to develop and we thought we were going to be able to ride on the management of the World Heritage but all of a sudden it’s already five months later and nothing’s really, I wouldn’t say nothing’s happened but it’s taking a while to get those things kicked into gear, waiting for the funding to come through, waiting for positions to be approved and all that sort of stuff. [With the World Heritage committee and the management...] Yeah. The management and how it flows out and all those sorts of things. I don’t know how long it took at Shark Bay but I think you wrote that plan years after...And we wanted to jump on the initial World Heritage announcement and start getting information out there but politically-wise these things just seem to tick along so slowly, it’s been really hard. But, it'll happen, it’s just...the nature of bureaucracy and it gets frustrating for us, so I can imagine how frustrating it gets for the community and other organisations. I don’t understand why things take so long so I can’t expect anyone else to either. So, all I can say is I share their frustrations but that doesn’t help the situation. But, we’ll get there it’s just a matter of time.

- obviously we’re hopeful that we will also have a World Heritage committee of some sort which I should imagine will take in those key players as well, which will, we're hanging on as our ongoing means of communications with the wider community and key agencies and those sorts of things.

- …you weren’t here for the community meeting that the CEO and the Shire organised for the town redevelopment and foreshore plans... They invited us to do some stuff on World Heritage. There was like 80 people there and it was just so positive because...people were sort of still maybe not agreeing with what was being said but they saw it as a proactive step, we weren't there justifying anything or arguing anything, we were just saying look, this is what it is, this is how it’s happening and people appreciated the opportunity to be informed about what was going on.

6.2 Models

6.2.1 Model training

- Yeah. I still think that the model itself is quite complicated for non-specialist users. But, that might just be the way it is I think. Like I’ve said a few times now, I think what worked is bringing people together but I know that’s not the aim of the program but I think that’s still an important spin-off. I think it was good that they came here to do the training and made an effort. I don’t know if there’s anyone who has actually used the model since but, I think it’s still worthwhile to at least have tried it.
6.2.2 Model uptake

• Having said that, in the six months since my project’s finished, I haven’t received any enquiries from anybody about using the model. So, you know, even though I think we did a reasonably good job, if we’re looking at uptake, something hasn’t happened … I think you can only go on like that for so long before you need to say well, got to draw a line in the sand, finish it up and then wait to see if people do actually come back to you or not.

• So, even though I think that the engagement process was certainly enriched by your involvement and all the effort we put into it, there still seems to be something not quite ticking over.

• The other point, here, and this is something that’s very difficult, came out of a conversation I had with a guy who worked in Dept of Ag in Western Australia. His comment was “well, when you build a model and it might take years and millions or thousands of dollars to build, sometimes people only need to see it two or three times, because then they take the model into their head and the model’s done its work and it doesn’t matter anymore, because the model is already in there”. So there’s also the possibility that the people who have seen it now have that model ticking over in their minds. I think someone like [name] does, I think when he sees a proposal or something going on, he’s influenced by the model and what he’s learnt by his engagement with the researchers. It’s hard to say how many other people think like that.

• [Was it a time lag? (that impeded model uptake) The regional context when the idea of the model germinated was quite different by the time the model was actually finished, did it not?] That’s going to be a problem with anything. The regional context changes almost completely every twelve months. So if that’s a barrier, it’s one that’s never going to be solved. Maybe if we had a small group of people at the start and brought them along the whole way and tried to make it core business of some of these positions to know about, then we might have had a better shot in the regions. But as I’m saying it wouldn’t have been picked up because the regions have very little influence over how the bureaucracy in Perth operates. That’s very clear.

6.2.3 Proactive planning/managing growth

• [Do you see any other roles for the models in terms of the Shire using them? What about the Research Centre, would they have a place in the Research Centre?] I’m sure they could and I would hope they would. Yeah. Definitely. There’s all sorts of things we could feed into that about visitor numbers, types of visitors and impacts. I think it can be a very helpful tool, just for planning ahead and trying to be ahead of the game rather than trying to be reactive. So much of what the Shire does has been and is reactive, and we’re trying to get ahead of that game. So that we don’t end up somewhere we don’t want to be…When you think about somewhere like Karratha, for instance, their growth there it would have been seen as wonderful initially, but now are they really happy with where they’re at?

• [It would be really interesting to go there (Karratha) and talk to folks and say, what took you here, is this the way you wanted to go, what would you have done differently? Because I think Exmouth could maybe learn from an exercise like that.] I think they could. I’ve met people recently who have come to town from Karratha and they’ve been long-term Karratha people and they’ve said ‘No, we can’t do it anymore, we’re coming here because this is like it used to be up there.’ [I know people in Exmouth who are talking about going to Denham because …] Because it used to be like that? [laughs] That’s it. So I mean, it’s inevitable we’ll have change but it’s just managing that ever so carefully.

• [This is what I keep telling people, I’ve obviously got an environmental slant, but really what it’s about is, if you’re making a lot of small decisions and just grabbing everything that comes, you might end up somewhere you never wanted to go. Just be careful.] Yeah, that’s right, you don’t suddenly want to get to the end of the road and go, ‘whoa…how did we get here?’ Yeah. What seems like a good idea at a time may not be at the end of the road.
6.2.4 Should have used a real local project for the model training to create local ownership

- Maybe. I’m just thinking about the question before, I think what could’ve been done as well; we never had a project. I think you need a local project that you can use the model for, it was sort of ad hoc how we questioned the model. I think at an earlier stage we should have worked on, say, a supply base and said that’s very likely going to happen, now can we work with the model and with some local interest, key stakeholders or people with an interest and see what that actually does. And I think that because we didn’t have something real to work with or work towards, we were just playing with the model and there was no real implication. [Just so you know, Beth, has been asked if she would run scenarios on those supply bases and she’s agreed to do that…] Yeah. And that’s where it becomes more real. I don’t know, it’s a bit like sitting in a car without the engine on, you can still play with the window wipers and press some buttons and turn up the volume but you’re not really driving.

- [I guess that’s an issue: Beth can go run the model, come up with some results, but then what?] That’s what I mean. Because we did not have a real need to use the model. We’ve done it in a workshop training session, but you need a real life situation where you can actually apply the model and I don’t think that the reference group or any potential users have said oh, we’ve got this issue or we’ve got this imminent question that we need to solve in our planning. We need to know what’s going to happen and therefore we need to use the model. [So, is that because there were no opportunities or because nobody put their hand up and said we need to run this through the model?] It could be a combination of both, I don’t know. From a Shire perspective, it was nice to know the questions that we came up with, but it didn’t have any policy implications or any decisions attached to that.

- The two key things that might have been missed is one, to come up with a specific, real life example to work on with the model, so people could actually see what it means on the ground for a real question or a real issue. Well, if you had, I think, say, the lay down areas where the oil and gas influence is in the area...Say the local business proposal, well it’s recent, if you lined it up and started working on that and started questioning what the implications are, good or bad, and how you can use the model for that. [So, do you mean just run the model or do you mean involving people in the process?] Yeah. Get the Shire planning officer in and get DEC in, get [local scientist] in. We talk about shipping, we talk about whales, we talk about recreation and tourism.

- [So, it’s not just Beth running the model in Tasmania and then sending it to you guys?] No. Not at all. No, no, Beth should come here and talk to all these people because it looks like a simple line on a plan and it’s not. It’s sticking up quite far, people are concerned whether they still have access to their favourite fishing spots, whether you can still drive along the beach there, what will it look like off the water, is it going to affect tourism that we’re not a pristine area anymore. So, there are all these questions in different sectors, not just environmental. How does it link with transport? Once you’ve got a barge facility, there’s going to be increased transport, if it’s going to be a supply base. So, how do we link all that and then you can ask the model how many kangaroos are going to be hit because there’s an increase in traffic, all these things.

- [So, would the benefit in that case be what the model spits out at the end or getting those people together to discuss it?] To discuss it and based on the discussion, you get the questions that you would like to answer…

- And see whether the model can actually answer those questions. [Because, Beth can run the model now and give you an answer.] Probably, yeah. No. I’m not asking for an answer on that one, I’m just using that as an example. Because the model is finished now, but to develop the model and to get people involved from an early stage and not just, we’ve got a model that’s nearly finished now give us a question. You could have involved people from an earlier stage a little bit more with a real life project. [And the benefit of that would have been?] Better understanding within the community I guess of what the model is all about, what it can do and the model would also be working towards that particular project or particular issue that we’re trying to deal with. So, I think the connection with the whole body of research would have been a bit better, it would have created opportunities to involve these people in particular parts of research. If Beth needed some data she could’ve asked community members or key
stakeholders who should be part of the data collection or whatever is needed and it would have created a bit more ownership maybe.

- [And so, when you say ownership; do you think it would’ve made people more or less accepting of what the model spat out at the end, if they were involved in…] It might be easier to accept and better to understand what it actually means. [And do you think that that would have an influence on whether the model got used again for another project?] Probably, yeah. If it works for the questions you’ve got and it gives you insight to which direction you should go with certain projects or addressing certain issues, I reckon you will start using it again because it’s a real life thing that you had to deal with as an officer or as the responsible person. [As opposed to just getting a report?] Yeah. Or as opposed to doing a training using some sort of made up issue which doesn’t really matter what the model outcome is, it’s just a fun figure … and I think it’s different and you create a bit of a ‘tribe’.

6.2.5 Custodian for models

- I’d say probably we suffered a big blow when the NSDC closed because I think they would have become a custodian of the model and picked it up and used it or asked for changes and then made use of it. So from being in a position where we had this group that was integral to planning in the region that would have used the model…[So they were the original client?] They were the original client, having said that, I don’t think they were identified, they were certainly identified by us at the start of the project but…[But it wasn’t a request from them for you guys to do the modelling?] Not a request from them but they agreed to be the custodian. So even in meetings, there were meetings where…[Before the model was even created …?] Oh, before the model was at a point where it was showing results.

- [Did the NSDC have much influence on the shape of the model?] Yes in as much as they were able to provide us with the questions that they wanted answered. And we had an understanding of the kinds of issues that they were interested in… although we were actually more driven by the results from our initial workshops. But when they [NSDC] dropped out of the picture with the change in government, we then didn’t find a logical successor because Planning was just chaos, they had no staff and were reorganising the regional planning system. DEC has an interest in it but it seems to be very internally focused, almost focused upwards in a way than… And then other areas know about it, Tourism WA got out of tourism planning. Regional Development and Lands don’t really do planning, they respond to requests. And local government has very finite resources, particularly in the shires of the size that we’re talking about, and to have someone trained up in using the model at that kind of level, when there’s a good possibility they’re just going to go anyway, well certainly in Exmouth that was a concern. In Carnarvon the planner just wasn’t interested. So maybe we were a bit unlucky, maybe that’s what happened, maybe we didn’t cultivate the area properly. But I think we tried really hard.

6.2.6 Keeping model up to date

- Exposure to the models is good and…I find the models really difficult just because I still have trouble coming to grips with how those models deal with such a dynamic environment, things are changing on a day-to-day basis, not just from the environmental point of view but from a political point of view and a community point of view and you just have to look at what’s happened in the past three or four weeks in terms of the announcements about building a facility down at what was originally the prawn factory. Three months ago that wasn’t even being considered and talked about and no-one really had any concerns or issues about it, but all of a sudden the climate changes and you get Wheatstone over at Onslow and that’s going to have all these massive flow impacts, so…and it’s not so much that things are changing, it’s also that you are all constantly learning more that you could add into that model and I’ve always been a little concerned that, not the way that model was established but the way that it’s kept live and useful over time and the information that we’re modelling from now is already, I don’t know, five years out of date or something along those lines.

- So, how do you keep it live and how do you keep it…and the best example I can use is that model still for all the practice sessions we did were based around the original Carnarvon Ningaloo coastal strategy
and that level of development along the coast and, as you are aware, the current government is looking at overturning that strategy or considering that, they’re reviewing it and so that could all just go out the window and all of a sudden the assumptions made there are out of date which is great if they get updated, but I’m concerned as to how that’s going to be updated and who takes responsibility for that. And I know there’s been a lot of talk about it but I still haven’t seen an outcome that says yeah, don’t worry about that that’s happening and we’re managing it and it’s going to keep on going like that. [Who’s going to be involved, if anyone?] Yeah, that’s right. Lots of good talk but I haven’t actually seen it come to a bit of a future point at this point in time.

6.2.7 Smaller stakeholder group/using simpler models

• [What about if you just went with a smaller group of people, smaller, and a simpler model that could be adapted more by the group…?] That’s what you’d do if you had a small group and that’s what we tried to do with a large group, at various points in the development show them the model and say ‘what else do we need to do, what are we missing here’. And I think a smaller group with more regular meetings perhaps, I’d say every four months or so, so three meetings a year, and maybe some emails in between, would give you quicker feedback in terms of picking up any issues and making sure the parameters are right. And a lot of it’s just about finding the parameters. But still a lot of it falls back onto whoever’s doing the model and their ability…

• Ultimately whatever we came up with would have been this kind of size anyway, because you’re not going to get across the tourism side of it plus the social plus the ecological plus the economic, unless you build a fairly big model. So [name’s] idea of using three models isn’t a bad one, at least then as people go along and they have a chance to engage with complexity and how complex systems work, I think that’s a good idea.

6.2.8 Educate stakeholders in phases (curriculum for models, complex systems & adaptive management)

• [Well, do you have any other suggestions for improvement or next steps…?] Yeah, yeah, I think I’ve run through a few of them. I think [name’s] on the right track too about how we use the models at different stages. So when you start the process you have almost like a curriculum you could say, where you grab a small group of people at the start and introduce these concepts at various stages, and at the same time use it to define the model - give them an education in adaptive management, and then they help build the model. So by the end of it, they’re familiar with the models, complex systems, how you can use adaptive management, and they trust the end product straight away because they built it, they’ve seen it the whole way. So that’s, I think, probably a better way than what we’ve tried to do in terms of the technical element.

6.2.9 Uptake in Perth bureaucracy

• What I haven’t really articulated is how you do any better with the bureaucracy in Perth – how do you get these guys to use the models themselves, and that’s something that I haven’t seen a clear answer to, through my experiences. At the end of the last workshop we ran, the feedback was fantastic, everybody liked what we did, they got it, I think they were able to use it, but no one’s come back and said they want anything extra or they want us to contribute to a process. [Well, it’ll be interesting to see what happens further down the road.] Yeah. I mean, that’s the negative spin. The positive spin is that the projects have been developed, the applications are in that would use the modelling. So there is stuff going on and that might be how we get it up, eventually, through these next few steps. Beth’s got a better chance than me there because they’re better resourced.
6.2.10 Mass communication tools to promote models

- [So in terms of ‘next steps’ for trying to keep the knowledge transfer happening?] Yeah, it's a really difficult one for me because of course I'm no longer really paid to do this sort of stuff. But I we'll release some of the mass communication tools we've come up with, the students' projects, in the next hopefully two or three months – and possibly by the end of the year. So I think that's an opportunity to refresh people's memories that the models are out there. These project haven't even been resourced, they're just extra activities that we want to finish because we've put so much time into the models. It'll be interesting to see how that goes because as we've both observed, large organisations are paranoid of public attention really.

6.3 Managing research program

6.3.1 Include regional people on management committee

- At the same time, from the broader projects or the cluster perspective as a whole, I'd put people from the region on the management committee for a start. I'd have some resources available for initiatives along the way, if the project is about uptake, so you could hook the research into various events and things that go on in the region. So that's three things right there.

- …and you'd try and get the management committee focused a bit more on regional events and initiatives so that they have a really good understanding of what's happening

6.3.2 Base someone in region

- Ideally you'd have someone based in the region, maybe a post-doc would be a good idea, if possible,

6.4 Engaging locals

6.4.1 Interview results – understanding other perspectives

- So we appreciated that, that was a return to us at least, we could see where our input was going and then at some stage you released summaries to everyone of all the interviews. That was very useful to us because it presented different points of view that weren't just our own. [Did you find that useful?] Yeah. That was useful

- [Did that interview compilation report; did that actually have any influence on what you guys do or the way you think?] I know that [redacted]’s read every page of it and I think it’s more a subtle influence but… we are open to different points of view. We strongly put our case forward, but it’s interesting to consider others’ points of view and it does filter into your thinking and into your responses, it may even make you more patient when dealing with Government agencies in future. It’s difficult to say if it has a direct concrete influence…it influences how you approach your work, it’s dangerous to work in isolation which is always an issue when you just run a business. But that's why it is important that researchers feed back to us because it will influence us.

- I think it’s been a really valuable process, especially going through and reading your interviews with other people. I felt that was really valuable, seeing other people’s perspective. On a personal level, I found it really valuable to take into account other people’s perspectives. I think that’s more effective than just running on your own agenda, to try and see where you can run together. [So, the interviews helped?] I thought it was really good hearing how other people felt and thought and how it could be integrated. I was really surprised by the level of interest that people had in the research and what was going on.
6.4.2 Communication with researchers

- I think the communications were excellent, Beth and Tod coming here on various occasions and keeping us informed so that was all really good. [Anyone else? There were other researchers in the program…] Yeah. They sort of came and went I think, some people. I know about the atlas thing, because there was a presentation. It was new to me and I’ve never been back to it and maybe I should check that website again and see what’s actually there now at the moment. But, I understand all these people are busy as well and they’re not in Exmouth as such so, it’s a bit hard from both sides I guess to stay in touch.

6.4.3 Work to create a tribe at the beginning of the research program

- You create a bit of a ‘tribe’, remember we talked about this last year, the TED talk? Well, that’s what’s missing, at the end the research program tried to create a ‘tribe’, but I think you have to do it when you start thinking about your project. I like that TED talk, whether it works or not, but ideally that’s what would’ve happened.
- that’s the second thing, real life [modelling project] plus the second thing, tribe type thing. It connects people from an early stage throughout. [So, create a tribe from the beginning of the research?] Yeah. Rather than try and establish it at the end and say this is the model and now we want some people to go with it. That’s not the way it works unfortunately. You have to capture people from earliest stages I think. Yeah, that’s my feeling.

6.4.4 Involve local people in research

- There seem to be all these researchers here and they’re research is being supported by the oil and gas companies and you never hear about it or I miss it. On occasion there is a presentation by a researcher. And the other thing I always wonder is how many local people are being involved in that research because I think that’s one of the things that you can do to involve people in research. I know they do it with the turtle program in a way, there’s volunteers getting involved. I think that’s one of the most important things that you can do as a researcher, to use local people because there’s a transfer of knowledge and there’s some ownership and they become the custodians of your research results in a way, and I think that might, maybe I came in too late, but I don’t know how that worked with this particular program. Maybe if some local people were involved from the start that there would be a bit more ownership and better understanding. [In actually conducting the research or developing the models or…] Yeah. Because I know that if I go back to Tod again because I know more about that part, I know that he brought university students to do surveys. I don’t know whether he used local people to actually participate too, which would have given the community more connection with it, you know what I mean? They would invite local people to talk to other local people about the topics in the survey, for example, and it starts to create something. I’m not sure whether that happens or not.
- [I came in at the end of the research program, any thoughts on whether there would have been benefit to having someone in that capacity for…] Yeah. It relates to what I said about involving local people in research. I keep saying if anyone wants to do something here, let me know and I’ll consider
volunteering. I’m not a person to run around on a footy field with a whistle, that type of volunteering. I like other stuff, I like clean up days and whatever, so research, to go and survey people, would have been something. There are people in the community who would want to be involved in that and I think that needs a person to coordinate it. I don’t think I’m the person but it could have been someone in your position, talking to the researchers to see how, from an early start, you can get local people involved in what they’re doing and how they’re going to roll it out.

6.4.5 Focus on engagement

- I think we need to build in more interaction from the start. It has to be down there as a part of the funding that can’t be cut away. It probably wouldn’t hurt to have a Kelly-like person in each project, in the region, to keep plugging away – that seems to have worked quite well. But yeah, I think it’s just about making sure that the connection is a lot closer than it has been in the past. Now that will present whole new challenges when you get to a much more populous place like the south west of Western Australia or, I’ve been in the discussion of how you’d actually apply it to the whole of Australia, which is interesting trying to think of it how you’d do engagement at a national level. So talking about art exhibitions and interactive art exhibitions or TV shows or that kind of stuff.

- But yeah, that’s the biggest challenge – how to effectively have that communication and that connection as you go to new questions and new locations. So the isolation ironically kind of helped this time round, it drove home why you needed communication and connections, I don’t think the need is actually less there when you get to a larger place, I just think it’s just been appreciated less. But going to a new place is going to chuck up new challenges about how you actually do it. And I think that’s been really well underlined by the difference in response we’ve had in Carnarvon and Exmouth. You get polite formal responses in Carnarvon, you get friendly interested responses in Exmouth. [And you think that’s because the level of engagement was different between the two?] Yeah. Level of engagement and level of interest and uptake and all of those kind of things. So, north of Quobba’s front post you actually get people interested, they’re not all going to buy in, they’re not all going to accept the models outright, if it gives us a bit of information, great. But they are interested and willing to help and willing to listen. South of Quobba, you get the odd person who’s willing and interested but on the main it’s like we’ve got better things to do, we don’t care what you’ve got to say.

- [Why do you think that is?] I think that there’s two parts to it. I think we spent per capita more time talking to the people in the north, and probably didn’t spend as much time trying to convince some of the doubters in the south. They also don’t see as much of their future tied up in Ningaloo, I think. But the guys further north do, there’s an immediacy that means that they’re more willing to engage if it’s going to give them a leg up. Carnarvon realises that even if it’s a gateway to Ningaloo it’s only ever going to be a gateway, they’re never going to get super numbers of people staying there for a tourist angle, they’re more about the culture and local issues, and we didn’t have as much focus on there so they didn’t see the reason to be linked in as much. So I think it’s partly focus and I think it’s partly there were a few doubting thomas’ there that we didn’t wear down. And the people that did become engaged have since moved on. So it’s a bit of a mini lesson of the whole thing that where it works it works really well, but nailing that engagement is pretty critical.

6.4.1 Lack of return for engaging with researchers

- Researchers need to be careful with creating expectations because at the end of the day it doesn’t matter how good any of the researchers are, they always leave. They don’t live in the region, they’re not there for the medium to long term, they’re short term, in and out. They get what they need which is a further academic qualification, they use a lot of time, a lot of favours, a lot of input for very little return. The legacy they create is that grass roots stakeholders like us don’t want to support research anymore because it costs us time and dollars. So it’s better for us to put our time and dollars into actual management outcomes on the ground, for example, policing illegal camping …$300 in time per week that we would have spent talking to researchers for two extra night patrols to pick up illegal campers that do the wrong thing environmentally. Researchers come in and out, hand out
surveys, campers fill it in, that’s it. Nothing changes because of what the researchers do. They just get
their qualification that they are after. So there is a perception on the ground that most researchers are a
very selfish breed…Not people like, say for example, Beth Fulton and you that included us, gave
feedback to us and worked with us. There’s a continuing work relationship there. We will support them,
even when it costs us time and money, of which we have little. But he majority of PhDs are just self
interested… pure, cold, hard, self interest to get that PhD, in and out, and to have a good holiday on the
side! Even if all we get in return for our time and contribution to the research is a copy of the final paper
with the research findings and results, that’s something. You always included us and you gave us the
output of your work and really, more than that you can’t ask for.

- [I guess while we’re on that topic, aside from me providing you guys with my thesis and my summary
report when they’re completed, and my thesis is probably up to a year away by the time it’s finalised, is
there anything I can do to help overcome that? To make sure that I meet your expectations I mean.] We
don’t include you in that assessment Kelly…If you asked time from us or you did interviews with us,
you would come back and say look, here’s the transcript, have a look at it, make sure it’s ok before we
release it. So we appreciated that, that was a return to us at least, we could see where our input
was going and then at some stage you released summaries to everyone of all the interviews.

- We participated a lot with you where normally we wouldn’t invest so much time because it’s yet another
PhD student needing to do research where we get no return out of our investment of time and
resources. In cold, hard dollars and time value, many, many, many PhD students want us to participate
with them, but the time we spent with them, means we don’t spend time on other important things that
the business needs on any particular day.

### 6.4.2 Host scientists in the community, more informal contact

- I’m not unhappy with the way things that happened, especially this year. I’m not unhappy with it at all,
with the research and our little groups, because I mean those things weren’t really happening. So, I
have to be really happy with those and of course being given the opportunity to be involved in them
was a big thing too. Could they be improved? Of course they could. Am I the person to be able to? I
don’t know. I’m an organiser, I like to organise things. Yeah, I would do it differently but it’d be my way. I
would have these groups and I’d bring them together in a different way, just the way I do things.
Different government agencies, scientists when they come into the community. I know the people that I
want to interact with. I’d have things in my own house ‘cause I like that, I want them to feel at ease.
When they come into the door being a scientist or whoever they are, I don’t want them to feel like ‘oh,
I’m walking into the den of inequity here because all these people are going to jump’. I want people to
be relaxed and I don’t necessarily mean drinking alcohol, but relaxed and I want them to come in
feeling relaxed so all of a sudden we’re off to a nice start anyway, because everybody’s feeling good
about themselves and the time…and then just generally start it off as a normal, sitting around
conversation. It doesn’t have to be you guys sit in the chairs over there and I’ll sit over here. And then
get their message across while they’re actually involved with the people, having a barbecue, chit chat,
there could even be, I’m a great believer in TV format, you could have a TV going on in the background
and all it might have is dugongs and whales and that jumping around, but it just keeps the atmosphere,
it’s whatever they’re talking about is there on the screen. So, throughout that three, four or five hours,
that’s part of the whole conversation, not wondering off to go talk about the football or you know.

- [It’s very interesting because in a way I’m sort of imagining it would be more the way you would maybe
host a rival footy club come to town, rather than a bunch of scientists keeping to themselves and
staying at the Novotel or at the Potshot Hotel …] Yeah. Stop that separation. They’re going to stay in
those places but…be organised with them. Now, if you came to me and said look, I’ve got these four
scientists coming to town…I would make sure that virtually, their feet aren’t touching the ground. I got
that job when Virgin Airlines came here. A few people approached me and said ‘look, can you look
after them?’ Not a problem in the world. So, I picked them up from the airport, I took them back to their
room, I said, ‘ladies, you’ve got ten minutes to get changed into your bathers, we’re off.’ And we spent
the whole day round the other side, then we came back and we had a barbecue with them and then we
gave them the spiel, or I gave them the spiel on Exmouth. I didn’t talk to them about Exmouth virtually
most of the day, I wanted them to relax and splash around and scream and shout and have a few drinks. Then that night we gave them the spiel and the next day we took them up to the canyons, we took them out to Kailis’, took them out to the navy base and showed them what we could out there, out to the towers ‘cause Willy was out there, we gave them a tour through there the next day, and then the next morning they flew back out. But I got letters back saying ‘it was one of the best tours we’ve ever been on, it was incredible, we only came up there to discuss the airlines and we got this huge tour.’ But it’s easy to do because you know these people are coming from Perth, Melbourne, Sydney where they live in a box, they work in a box and a lot of scientists do too, a lot of scientists live and work in boxes. Even though a guy might come out here and do whale shark tagging for three months of the year, but after that he might become stuck in an office or stuck in an environment doing some other type of tagging but all of a sudden you’ve taken him, come with me and now we’re going to do this for the day, it’s something different. [So billeting scientists in family homes?] Yeah, in family homes. You could always ask, you put a thing out to…you’re never going to know if you don’t try, put a request out…

6.4.3 Involving community requires knowing the community

• And then community involvement. I used to run anything goes and that down here, it’s very easy to get people, you just have to work. Once know your community, you’ve got to work at the centre of their head and think what will they be involved in? How do you get them to come and listen and put their money in and their thoughts? Ok. First of all, do I want to have something with alcohol involved in it? So, that’s probably yes, unfortunately. Then there has to be entertainment value there for them too, something that’s going to want to make them come to it. So, that’s quite easy to do. And then, once I’ve got the alcohol and involvement, then I’m going to entertain them, then they’re going to get entertained by the people that are hopefully going to associate with them. So, yeah, I’m one of those people if you came to me and said ‘look I’ve got four scientists coming here next week and I want to do this, this and this with them, what do you think you could do for me?’ And I’d have to sit down and think about it for a while, then I would come up with something and come back and say, what do you think about this.

6.4.4 Identifying community leaders/champions

• [But how does, say, a scientist from Hobart know about someone like you in a community? Normally they would go to the Shire and say we’re coming to town, who do we need to talk to?] Ring them. Email them. [But would the Shire know about you?]…Well, you would like to think that they would pick on people that were in the community. The Shire should know pretty well three quarters of their community. [Wouldn’t they likely say oh well, come and have a meeting with us and we’ll have a couple of councillors there or a planner and that would be it, wouldn’t it?] Yeah. But I mean once the scientists have been here too and met a couple people like myself, it probably wouldn’t hurt them to take names and addresses. And when they leave here they go away with that information and every now and then pop you through an email. Doesn’t have to be big and I know they’re busy people…For those type of things to work, there always has to be that connection and that connection’s really information in a lot of ways. It’s like ‘hi, what are you doing, I just wanted to let you know…’ But I know it’s hard because a lot of them just haven’t even got the time to type that. But then when you think about it, yes they have, it’s not that hard.

• But you don’t want to have contact with a lot of people, you only need contact with one person in the community because then they say ‘well, look we’re thinking about next year we’re going to come back for a week, do you think accommodation-wise we could get accommodated in a tent at the side of the house or a caravan, instead of spending copious amounts of research money on accommodation.’ Yeah, it’s a hard one. [It’s just interesting, because in a way when you’re in officialdom, whether that’s in academia or government or even business, you’re very focussed on people’s official capacity. So, if you’re coming into a community with the idea of who’s the planner, who runs the local DEC office, you’re not thinking who’s [a key socially-connected person] in this community. How would you even find this person? I don’t know how you get around that but that’s kind of what I can see is a limitation.] Yeah. And one of the limitations…when Beth and all the others came here. If you hadn’t of been connected that would never have happened. You see, those things are natural and came from
one connection. [And that was a chance connection because otherwise I would never have met you]. Yeah. It’s a hard one. It is hard. But, I like to think that when those people do come here, if we know what they’re doing, that it’s up to the community too to get involved….I know that that day the scientists came here, they were very relaxed ’cause there’s not a care in the world, there’s nobody here that’s going to put any pressure on them, they might ask them questions but they don’t have pressure. And they’re not even pressurised.

6.4.5 Development is creating an imperative

- The other thing that you’ve probably been…whilst there has been some unfortunately things with the timing in terms of the world heritage and those sorts of things, I think you’ve possibly been fortunate in the timing in terms of all the development that’s proposed for the area as well ’cause it really has heightened people’s concerns..[It’s created an imperative that wasn’t there when I first arrived…?] The past year or so, everyone’s just so much more, wow, there’s all this stuff could potentially happen on our doorstep, is it good, is it bad and how are we going to…how do we make that decision?

6.4.6 Personal vs professional relationships in NW

- [A friend of mine who was born and raised Carnarvon said the thing that a lot of people from Perth don’t realise when they come up and work in the north west, there’s no separation between your personal and your professional lives] Oh, exactly. [Whereas when you’re in the city, your professional relationships are very different from your personal; so then people don’t realise that you have to have the personal before you can have a good professional relationship up here.] Without a doubt. It’s different and it is hard. It makes it really hard and I think it’s hard here, I can only appreciate how much harder it is in Shark Bay where it’s an even smaller community. Nothing truer could be said, you’ve really got to have some personal standing in the community for people to respect what the agency’s doing. And, yeah, I go out of my way to make sure that our staff are as known as they can be in the community, but at the same time you’ve got to be so careful they don’t go out there and…[Be known for the wrong reasons. You can’t tell people what not to do in their private lives.] Yeah, so it’s a fine balance but it does make a huge difference.

- [And for a researcher coming up with no connection, even an agency connection in town, it’s even harder I think.] That’s definitely just one of the extra challenges to the whole thing.

6.4.7 Change in regional agency heads

- [The other thing that happened was the change in the heads of agencies. So, there was a bunch of fresh new people who came in at once….] I think it’s positive. It just is far easier to work in this environment at the moment than what it could be, for sure. But a lot of that’s come from a lot of good long years of work done by my predecessors and those of the Shire CEO and the GDC officer, they’ve probably gone through some of the shitty years and got it to the point that it is now or developed to the stage it is now. So, it evolves and I guess I should imagine it’ll go in waves too, there will be high points and there will be low points.

6.5 Reference group and research coordinator

6.5.1 General (positive)

- Setting up the reference group was a really good idea. So that had some implications as well.
6.5.2 Not much impact

- [With respect to the reference group; do you have any thoughts around that?] What’s the reference group? [That says it all pretty much]. Well, its been a challenge with, not just this project, I’m on so many, I don’t know, I just turned up if I got an invitation. I have no problem with that, but I never had a feeling I wasted my time attending whatever meeting it was.

6.5.3 Networking/bringing people together

- [So, you thought there was some value to those reference group meetings?] There was huge value in those. I think it was actually taking the time to sit down and hear information and share information rather than all the groups working independently because there’s a lot of groups out there who’s focus might not be conservation, but who don’t necessarily want to be anti-conservation, it’s just not their main project or objective. But, they’re not deliberately being anti-conservation, sometimes it’s unintentional or they’re unaware of information etc. And I think its good when people sit down, in person, there’s huge value in that because you’re actually acknowledging that this is a person and it’s not just an email. That face to face communication is quite valuable. People are really busy and I’m sure they get hundreds of emails a day. Whereas when you’ve actually made a specific time to meet, then your focus is on exactly that, not all other things you have to do. The message comes in a bit stronger when it’s actually verbally said to you as opposed to you just reading something, which is kind of how we tend to interact these days.

- [Do you think it had any benefit, getting those people together?] Well, to me the benefit was just to meet these people and continue catching up with them. [So, is the networking?] Yeah. And that’s to do with my role. [But, do you think there was any added benefit to having the reference group as opposed to, say, just having Todd and Beth come up?] Oh, I don’t think the reference group in themselves did give much reference. [Well, I think mostly they were focussed on advertising the presentations and things.] Yeah. Can’t really say much but…No. I haven’t given it much thought. I sort of came in half way I think so a lot of it was in place.

- [So, you think the reference group had an effect?] Oh definitely, definitely. I think, how can I put it, it brought people together to discuss those common issues and common future. I think, and nothing personal, I think it would have been good if that had been run by one of the agencies in town, not by us, and that it had been accepted as a formal group that met regularly to discuss these issues. But, that wasn’t going to happen so you did what you needed to do and I think that was exceptional. Because there’s no way in the world I would have ever sat around with the likes of the Shire and GDC, the Shire President and those guys just having those, what were fairly informal type discussions about how things are going to pan out in the future. So, yeah, it was great. Because there’s no other forum for that in the community.

- [there’s a big vacuum between all the agencies. Well, that’s what I thought.] No, there is or there was. That reference group has helped develop relationships and even if that reference group doesn’t meet anymore, as I said earlier, I’ve got a whole lot better understanding and appreciation of the GDC officer’s views and the Shire CEO’s views and everybody’s opinions on these things and what they want out of it and, to me, that’s opened the door for ongoing communications, which wouldn’t have happened previously.

- [Are you having any kind of regular or irregular contact with certain agencies or individuals?] No. I must admit, the reference group that you were coordinating, I’m not sure what role you were playing or what you call it, but that you were pulling together was probably the best forum that we had going in terms of that communication.

6.5.4 Formal vs informal meetings

- [Do you think there’s benefit of having (informal meetings) versus the formal chaired?] I think so, personally, I do. I much prefer to operate under those circumstances and I just find it easier ‘cause
sometimes those formal meetings just become spending more time doing the formal parts than the
general discussion and people voicing their opinions. And people don’t voice their opinions so much in
those forums either, they know it’s all going to be recorded forever more and people are a lot more
cautious. Not that you need to be cautious but people, yeah, a bit more restricted on what they might
say.

6.5.5 Built trust

- The only other point that’s somehow worth incorporating is that it was always going to be a be touchy and
difficult time for us with the world heritage stuff going on in the background and also with the pastoral
exclusion process going on in the background. To us that was always in the background and it was
always some… quite a bit of hostility from some parts and a lot of mistrust from some parts and so,
we were always coming in from that in the background. I don’t know whether there’s ever going to
be a time where we don’t have something like that in the background, but… [It was pretty hot]. It was
very hot. But I think it actually helped dissolve some of that to be honest. I think… well I like to think the
fact that we, was interacting with key staff from the GDC and the Shire that they, hopefully, developed
a little bit more personal trust in myself and my intentions and the Department’s intentions as opposed
to us being another faceless organisation and ultimately that’s probably the best thing that comes out of
it, is that it puts a person to the organisation and the relationship between the organisations to allow
honest discussions that you don’t necessarily agree with but you see it’s coming from the right place.

6.5.1 Should have been coordinated by someone internal to community/by an agency

- And look, I’ll just say and once again please don’t take this personally, but as I say, if that reference
group had been from within the community and I’m not saying you’re not part of the community but you
sort of coming in as a researcher and from my point of view I was going well, what’s going on, this
researcher’s assessing how we’re doing our job and how people are interacting and you sort of, you’re
a little bit standoffish to start off with. So, to have an internal person coordinate those things and
develop them I think would have got it to the stage it’s at now a whole lot quicker. And that’s not
because of you as an individual, it’s just…

- In a world where the research isn’t happening in the background, development of that reference group
and the way that you did it would have been ideal but that would have been you as a member of the
community or working for GDC.

- It would’ve been nice if the GDC or even the conservation group, although they’re probably seen as too
far on the green side… or the Chamber of Commerce, that would have been interesting to see how they
facilitated it. But something like that.

6.5.2 Research coordinator

- I think [research coordinator] role’s been a bit disappointing. It’s probably funding-based
because it’s been so intermittent that he hasn’t been available. I think that was kind of little bit of a lost
opportunity there. It could be quite, a really valuable position. [I think he really focused on the Whale
Shark Festival and getting the research profile….] And the Whale Shark Festival was good because
there was heaps of research there. [Ok. So, that seemed like a good investment?] Definitely.

- Well, tying people together should have continued after you left. That relationship could have kept
going, sharing information.
6.5.2.1 Role in Whale Shark Festival

- And also having the research coordinator, I think, has had a very positive influence on the final stage of the project in as much, in that you were central to getting that up. Well, probably the most practical way it was most beneficial was in the final Whale Shark Festival, they put a fair bit of emphasis on the research program. [research coordinator] pretty much organised the bits of the festival which we were involved in, he made sure that we were well situated, and that all worked. Without him my understanding is it wouldn’t have worked at all. So I think having someone based in the region then was essential to make sure engagement actually occurred. And the turnout we had at the public presentations was very good – again –that really is down to his work there in arranging that.

6.5.2.2 Role in Grant applications

- But he’s also done other stuff in the region, it’s very hard for me to judge [research coordinator] from Perth. But I get updates from him every now and again and the last couple of things he was involved were the applications for Royalties for Regions grants for a community monitoring program with Beth and the CSIRO, for potentially $300,000, so that’s a great initiative that he helped get up. The other thing was I put him in touch with a guy to put in a grant to do the business case for the Ningaloo Research Centre building. So you can see the flow-on effects of these kinds of initiatives. So we may have created someone who is a regionally based person who’s passionate about science, who is quickly going to have the capacity to put in high quality applications. And that’s a positive for the region.

6.5.2.3 Role in Project management

- So even though he may not operate the same way that we potentially expected him to, he’s still doing some really good things there. His strengths are actually around planning and project management and organisation, rather than generating new ideas, communications, that type of stuff isn’t something he finds easy. But he’s clearly a very organised and very intelligent person who when he gets something in his mind to do it, he’s very good at getting it done.

6.5.2.4 Research coordinator

- I guess having [research coordinator] in the region was meant to address that, [model uptake] but he didn’t really do much promotion of the models, and I don’t think he’s completely to blame for that because he really needed more training with them and more familiarity to be able to take them to people. As for the presentations, part of his role was meant to go away and say ‘if this is going on, why don’t you use the models to do it’ and I guess that’s probably one area that he hasn’t been as effective as what we would have liked.

6.5.3 Delays in funding research coordinator

- Don’t ask my opinion about the recent research coordinator funding process. You know the one they’ve been trying to get via the Exmouth GDC. There was going to be, while you were away, some money for somebody to act in a knowledge transfer facilitation role about the Ningaloo Cluster research findings. [Did you not want to speak about that or do you want to speak about it, because you’re welcome to have your say?] Yeah. It’s just that nothing came of that, lots of talking, no result on the ground. I’m not directing this at you. I’m directing this at whichever Government Agencies or Departments were involved in the process…too much talking and endless assessments, but no results. Results do not amount to following internal process, investigation and risk assessment and six months or one year later we still don’t have a person on the ground doing the work. What counts is somebody like you on the ground working with grass roots stakeholders like us. Everything before that is really just
behind the scenes planning, assessment and consideration that burns up the little available money that should have gone towards paying someone to actually act in the role. [That was one of the benefits of me not being associated with an agency.] Yeah. It's just there was a green light given for funding for a knowledge transfer facilitation role about the Ningaloo Cluster research findings, there was going to be a six month position of somebody like you that was going to help with knowledge transfer on the ground and then in the end, zip, zero, nothing happened on the ground. They're probably still planning and risk assessing it.

- [What ended up happening is that they did hire someone but most of his time got sucked up doing the Whale Shark Festival in Exmouth.] Serious, the Whale Shark Festival?! What does that have to do with knowledge transfer of Ningaloo Cluster research findings to grassroots stakeholders like us and others outside Exmouth township? [...] That was not what that money was for. We did not ask for a whale shark coordinator!! [No, he wasn't doing the whale shark stuff, he was doing the Ningaloo cluster stuff as part of the festival...] Oh, ok.

6.5.4 All talk no action

- [Do you have any comments on the reference group?] I think it didn’t work in practice. I did not see a change or any actions on the ground as a result of it. When I say 'on the ground' I mean purely from our point of view. At Gnaraloo, in Carnarvon, any of the other coastal pastoral stations. No, I didn't see anything come out of it. It was a lot of meetings, lots of talking. [What was your expectation of what would come out of it?] I thought it was going to be a coordinating group to get the Ningaloo Cluster research findings out to the ground. I thought that was their key objective, was to at least set it up so that it could happen. [Yeah. I think part of it was they were going to try. They didn't have much money but that was certainly part of it.]

- There was no appreciation of the value of commercial time and it was not good use of commercial time. and I are now of the opinion that we don’t want to be on committees because they’re just talk and talk and burn time, they don’t result in positive actions or changes on the ground. I can pick up the phone to Beth Fulton or others like her and say, "I hear you’re doing a paper or this or that, can we work together?" They agree and three months later we’ve got a paper out and many other positive things happen as a result of that. This perpetual talking and governance processes are very frustrating…We are in private sector so we’re used to action, resolution, problem solving and quick adjustments, even if not the best initial outcome, you re-adjust, and fix it. When you put us on those reference groups or management committees and it keeps wheel spinning and wheel spinning, it actually makes us resistant to the whole lot, even the good stuff. Because we think it’s all like this. They just burn money and it doesn’t result in anything on the ground… [just to keep things clear, the idea for that research coordinator and that reference group did primarily come from me and my discussions with different people in the Exmouth community – just so you know it wasn’t a government thing, it wasn’t the GDC or anything.] I think it was a good initiative and we all agreed with it, we participated with it as we thought it may result in positive outcomes on the ground…

- We’re used to shoestring budgets and getting a lot of action out of a little bit of money. When we see these processes burn money with endless talking and assessments, we say you know what, we could have done something better with that 20,000 or 10,000 or 5,000. If we had a two-hour meeting with the key involved players, for that $5,000, the community could have had a chemical toilet at a public day use site on the Ningaloo coast. That would have been positive a concrete outcome on the ground.

- So, important considerations are: mandate, jurisdiction and funding before something is commenced, because it alienates people when it spins into nothing. The problem is that people in government talk to each other, fully understand what's going on, keep each other in the loop, they're on pace with each other, they understand the pressures each department is under. We just see delays. [Now, if they'd actually got a coordinator on the ground and they'd actually got some stuff out to folks; would that have changed your thinking about that model?] I think so. If there was something like the two days I invested in Exmouth during 2009 where I walked away with so much new information about the Ningaloo
ecosystem and the biophysical environment around the lagoon, why it matters, why it’s different. We then tell our guests and clients why they shouldn’t do certain things on the coast. We’re focused on practical outcomes on the ground and changes of behaviour and public visitation management, because those are the things that will make this area worse or keep it as good as it is.

6.5.5 Funding & mandate

- I’ll come back to this and I think that it’s a key issue: mandate. Don’t have a reference group if it doesn’t have funding or a clear mandate, authority and jurisdiction to do something as a result of its involvement or facilitation. Same with the research coordinator position. If it’s something that’s just ‘maybe we can see if we can make something better,’ it may actually do more harm than good. [Ok. So you thought that that had a negative impact; the reference group and the coordinator?] It made me not want to be on any more reference groups.

- Otherwise, what else could have been done differently? I guess the obvious thing that could have been done differently is that there could have been funding and money and things to back it as it ran along ‘cause basically it was scrounging right from the start and finding bits and pieces, what was it $12,000 here and whatever it was, which…[Well, none of it was planned, it all just sort of happened out of the blue.] Exactly. And you go well, if it’s a serious and important thing which it obviously was, it should have been resourced and perhaps that’s where us as an agency should have had discussions earlier about how we’re going to resource these things and feed, not us into managing these things, but actually just in supporting them given the benefits that were going to flow back to us from the community. [In terms of the stakeholder engagement?]

- In essence if, looking back on it now, if there’d been an opportunity I probably could have set aside more money in my budget to run it, well not to run it, to facilitate it or help facilitate it or fund part of it and I think, I did suggest that at some stage in some of those, probably not in those formal meetings that we probably would be able to find some funds but at the same time I was loathe to contribute a whole lot of cash because I didn’t want to be seen to be trying to take over it as well.

- I didn’t want to say oh yeah DEC will pay 15,000 bucks towards it because everyone would just go oh, DECs just trying to buy control of the thing again. So, it was difficult to do that.

6.6 Adaptive approach

- It was certainly an adaptive process. I’m never very organised, to be honest, I’m not one of these people that maps out my life and says by this age you’ll have done this thing, which means that my projects do tend to be chaos. But this was a more adaptive process I think than anything else has ever been. But actually I think it wouldn’t have worked if it had been more hardly defined. Part of that is justifying my own disorganisation no doubt, but part of it I think is something that [redacted] at least agrees with, Tod agrees with. I think it’s going to become a basis for how we do things more into the future, that we’re going to have to have milestones for funding purposes regardless, but we’re going to take it a little bit more adaptively as to what the form looks like or how we do connections. We’re certainly always going to do the kind of ego network connection stuff that [redacted] and [redacted] started up there, with formalising the conceptual model phase and all of those multi-model steps, it certainly looks like it’s going to become a more formal way that we do things. So I think it’s becoming a prototype for how a lot of the research, at least in the next five to ten years, will play out well. I guess after that we’ll see how it worked and whether we need to adapt again. But I think it’s going to have a fairly long-term footprint on the way that we do things.
6.7 **Next steps**

6.7.1 **Regional heads of agency meetings**

- [Are you having any kind of regular or irregular contact with certain agencies or individuals?] No. I must admit, the reference group that you were coordinating, I’m not sure what role you were playing or what you call it, but that you were pulling together was probably the best forum that we had going in terms of that communication. But to the Shire CEO’s credit, he’s also just starting up a heads of agency meeting which I’ve chatted to him about before and think it’s a great idea so, that’s going to be happening on a bi-annual basis or something like that. So, just to pass on information. [Do you think there’s any chance you could attribute that to our little lunch meeting at Whalers?] I wasn’t at the last meeting at Whaler’s, I wasn’t there. But I know when he first arrived he mentioned it to me, it was something that he had initiated wherever he was previously, and I think he’d done it before... But I think what you’ve been doing has certainly, and the reference group, has certainly highlighted some of the issues and concerns that I’ve got no doubt will be on the table at those meetings. The environment and development and how that flows out in the community. So, it’s definitely had an impact on it and I think, I’m not sure how that reference group’s going to pan out, whether it’s going to keep going, it seems to have gone pretty quiet lately. So, if this creates another forum for it then that’s great.

- What the Shire CEO’s suggesting in terms of these heads of agency meetings are going to be the precursor to a bi-annual community information session …fantastic, so it’s just that people get used to it and it becomes the norm.

6.7.2 **Community information session(s)**

- The Shire had a community information session, it was in July and they had a few different topics and it was so well received, I think about 80 people attended, that they’re thinking of making it a regular event. I think that’s an opportunity for some researchers to present very short versions of their findings, because you’re getting a more general audience. It might be combined with a whole heap of different things that are going on,

6.7.3 **Follow-up symposium**

- My one request remains that we need a follow-up symposium on the excellent forum held in Exmouth during 2009 to divulge research results to grassroots stakeholders like us and others in the tourism industry. [Where would that be?] Last time it was in Exmouth, I guess it would make it slightly more accessible if it was in Coral Bay, but that would still be an expensive option travel and accommodation wise. I would even say Perth, because it’s not going to be in Carnarvon, let’s face it. Exmouth is hard to get to and very expensive, but then who is the target audience and where’s the majority of that target audience? If they are all in Exmouth, the rest of us would just have to get there. If a lot of people can get to Perth easily and cost effectively, maybe it’s better to hold it in Perth. But then everybody in the region would criticise you for holding it in Perth, and not in the region. [Well you know WAMSI just had a conference last month in Perth with their Ningaloo stuff. Did you hear about that?]

6.7.4 **Highlighting knowledge transfer challenges in PhD thesis**

- [One of my concerns was me coming in and then leaving doing more harm than good] Coming in and leaving, that’s clever like a control in an experiment. [Well, I needed to see if any of the things that I’d started stuck.] And did it? [Well, some things did, some things didn’t.] You know what Kelly, that’s the thing, instead of getting down about it, just view it as an organic process. We all plant ten seed, one grows. If we didn’t plant the ten, we couldn’t predict which one was going to grow. Just keep going because if you don’t keep sowing the seeds, none will grow and you can’t predict which ones are going to work... At least you had the drive and the guts to try, and together we tried to strike a flame so
it didn’t turn into a massive roaring fire, so what. It’s worse for people who don’t even try… And the process isn’t over. You’re still writing your thesis. I hope the final thesis will summarise and highlight some of these challenges. The process isn’t over, until the final thesis is put in front of key decision makers so they can consider it… Maybe you can do a two-page or three-page summary of it, of key wins, key challenges, key lessons learnt. It would be good if that went to relevant Director Generals and key decision makers in Government. The top guys at DEC should read it, as well as the top guys in Planning and the top guys in Lands, etc.

6.7.5 Continue presenting information

- I think it’ll be good to keep presenting information where possible. I think the WAMSI presentation was good in that sense that at least it brings people’s attention back to the fact that these models are there. And after that it’ll come down to keeping an eye on what’s going on in the region and potentially sending submissions when I find out about stuff. I’m not watching it that closely, that’s the issue.

6.7.6 Keep it coming

- Well, I think it’s going good and I think we need to keep it coming, and I think it’ll be always changing and evolving too, like people change and the way we communicate changes. But from our Shire perspective we’re making changes.
- Somehow you’ve got to have one person who’s doing nothing but pushing that one barrow to keep it rolling along I think and resourcing for that is always going to be a hard thing. You’ve always got to balance up what you resource and where you put your money and where you put the people and, yeah, I guess we’re just not in that position to do that at the moment.
7 Can you see other applications for this process?

7.1 Sustainable development projects

- Oh yes. Anywhere you want to do regional sustainable development, even national sustainable development, where you’d need more than one person in that role. Yeah, anywhere that you’re doing any kind of multiple use management questions and management, there is room for that role. So they’re already looking at Kimberley, but you could do south west Western Australia, you could do anywhere in Australia, anywhere, any coast of any nation, it doesn’t even need to be coastal. It could be completely marine, completely terrestrial, it’s just almost like a global, you could drop a pin anywhere in the world and you could use this approach. [And that being the stakeholder engagement focus?]
  Yes.

7.2 World Heritage/Parks planning

7.2.1 General

- Based on the definition of it being a knowledge transfer process, I guess it particularly relates to when you’ve got a whole lot of information that you need to get out of there based on research that’s been occurring. But, I guess in any of our planning processes and any world heritage listings or any changes to sanctuary zones, whatever it might be, the more communications and knowledge and interaction you have with the community the better it is. It’s easy to say that and it doesn’t always pan out because sometimes people don’t want to listen but perhaps by having a key reference group like that, that you can have those informal discussions amongst community, I wouldn’t say community leaders, but community agents, representatives you quite often can disperse some of the misconceptions before they start. This is a different scenario because it wasn’t about misconceptions, it was purely about getting information out there.

7.2.2 World Heritage

- [just to chuck the thought out there; one person has suggested that a similar process could be applied to World Heritage, getting people together and learning about it by presentations and…] Oh, yeah. No. I’m all for it because it’s been three months now since World Heritage was announced, and we haven’t seen a single Minister, nothing has changed which in a way is good I guess, a lot of people were afraid that a lot of things were going to change for the worse, but it’s not being acknowledged, it’s not being celebrated, people aren’t being educated about it, there’s nothing…oh there’s some brochures out now made by DEC that informs people about World Heritage, but the other values of World Heritage need to be out there I think. But yeah, maybe we should come up with a plan and see what it really means now, World Heritage. People keep saying oh, we’re the custodians and we look after the place and in my view the majority of the people here love the place but all we do is take from it, whether you take a fish or whether you take a photo, but looking after the place in terms of giving something back, restoring it or educating other people to look after the place, I think we can do a bit more. So, I think it’s a lot of talk. Even myself, I wouldn’t call myself a greenie but I don’t do much to look after the place. I don’t catch many fish, but I do scuba dive and take some photos and I know that I will stir up some stuff and it will knock something over now and then, but I don’t really do much to restore it or make it better or…and again, like when you talk about world heritage, maybe this is something that we should start thinking about, where are the, except for the Cape Conservation Group, where are the community groups that do stuff, that say we look after this place and we’re going to educate tourists before they
chuck their boat in to go fishing, make sure that they know where they can go fishing and where not. That we make sure when people go and take their own boat to go whale watching that they know how far they have to stay away from it and how to approach it and make sure that they have the brochure, who’s doing that? I think as a community I think we’ve got a responsibility. I’m not doing it. I don’t know anyone who’s doing it and it’s relatively easy. You only do two hours in the morning, for example. Not to say that that’s the thing that we need to do, but you talk about World Heritage whether it’s under that umbrella or not, but I think those are the things that as a community we could do and it’s got nothing to do with modelling, it’s just on the ground action, there are things that we know you can and cannot do in this area and, yeah, someone needs to coordinate that. And the Shire doesn’t have the staff to do that. DEC does to a certain extent, they’ve got their programs, but I think we could do heaps more. And I think because we’re world heritage now, well we’ve got a responsibility to do much more and not just wait for, I’m talking as a community member now, not just wait for agencies to do it. But maybe agencies need to help community members to help themselves, give them a platform.

- *Do you think there would be any benefit to having, because people don’t really understand World Heritage, they don’t know what it means, some sort of process to get the word out about why it’s World Heritage listed, what it actually means to be world heritage listed, what the actual implication are…?*

It’s a question for DEC again I think and what they’ve done pretty early on is get some brochures out about what World Heritage is, and that went through eels, the email service, and that went down pretty well and a lot of people received that. We had a community forum which we’re going to do twice a year and we invited DEC (the community forum is basically an information evening for community members) to do a bit of a talk about World Heritage and answer some questions and I was quite impressed actually, we had 80 people turn up which is quite a lot for Exmouth. So, we had some good topics I think and again, it was an opportunity for DEC to talk about World Heritage and what it means and what it doesn’t mean. But, yeah, we could do a bit more I think, you don’t have to mention it all the time, but we haven’t seen single Minister, state or federal come here and say congratulations on your new status. So, that’s another thing, state and federal have put the nomination up and then we got it and then we don’t hear from them. It’s a bit funny. They just went to the Kimberley because they the largest national heritage area and the Minister is there to congratulate everyone.

### 7.2.3 Keeping community up to date

- I think in any of our planning processes and I guess that’s where we try and use things like the Coral Coast parks advisory committee and all those sorts of things, but they’re always seen as a DEC funded organisation and they’ve always got that angle on them from the start. So a community based one would certainly help in those things in the future and I’ve got no doubt that I’ll be trying to have that sort of… I’ll be using things like the Shire CEO’s forum that he’s setting up for our key management issues and what’s going on and informing that high level of community of what’s happening on a day-to-day basis. And if they can be ongoing, it’s far better to have them ongoing as is to all of a sudden, oh, shit we’ve got to write a new management plan, let’s get a group together immediately beforehand and pump all this information in and then deal with it as opposed to keeping people up to date and informed all the way through the process or on…irrelevant of where there’s a process or not. *Just so they know what’s going on and if they say you haven’t told us, you can say…* And you’ll still get people who will say that and that’s fine but I think ongoing and consistent communications is far better than packaged for an issue-type communications, without a doubt.

### 7.3 Ningaloo Research Centre

- Yeah, just using every avenue that’s available, like I said, taking every opportunity. And then finding creative ways within our Centre to communicate to people. *So, like the Research Centre would be another potential application where this way of getting the information out…* Yeah, absolutely. If that Centre goes as we intend it, has a variety of ways of reaching people, it won’t matter what age group, it won’t matter what their understanding of Australia as a visitor or whatever, they should be able to go away from that Centre with some new knowledge and some new understanding about the region that
we’re sitting. We’re going to be in such a unique situation here, well, we are now in a very unique situation. We’re book-ended by World Heritage. This Gascoyne region from Shark Bay to Exmouth is World Heritage, it’s quite unique and extremely special so…yeah, we need people to appreciate it.

- I see it being very helpful in particular when we build the Ningaloo Centre, it has given us the starter model, and started to achieve what we want to achieve – communicating science to the general public, connecting science to the general public. So we want people who come up to Exmouth, Ningaloo World Heritage listed region, to know what they’re coming to visit and how to treat it and how to appreciate it and what kind of research has been done here and how that might impact. How they might volunteer or be a part of it. So it really creates an inclusiveness – it’s not just about community, it’s about the visitors as well.

7.4 Regional Planning

7.4.1 Understanding drivers of regional change

- I actually think that it’s got a fairly broad applicability if you want people to start understanding some of the drivers of change in the places they live at a regional level. There are not that many tools that do that in Australia. And we’ve managed to develop one that’s been quite well received to this point. So yes, I think it could be applied certainly, it could be applied in another place.

7.4.2 Planning together for the future (other industries & places)

- … and you could even move beyond tourism and engage in the kind of learning process that we’ve spoken about, and management process which is more about trying to get people to move towards a more adaptive way and more collaborative way of planning for the future. And I think that’s probably the context for this conversation really, because it’s not really about model uptake, it’s really about you get people to a position where they can collaboratively plan and in a way that takes a more holistic view of the future – that’s really what this is about. Not just oh, are they going to use this thing. So yeah, I think we can do that better now and I think you could do it in another place and with other industries.
8 Thoughts on knowledge brokering role

8.1 General

- [Anything else you’d like to add?] No. That was good. You did a good job.

8.2 Networking

8.2.1 Connecting people

- Yeah, I think it certainly helped people remember that we were there – not being there on a daily basis does mean you’re out of mind, out of sight. I do think it helped people remember that we were there. I do think it challenged people to listen. I do think it was a case of you also teaching us the value of perseverance, it’s the fact that you have to go visit the community all 27 times before anyone turns up but then you’re seen to have made the effort. So I think it, both for as a community contact digging out little snippets of information that wouldn’t have otherwise arisen, being there to connect people who should have been connecting but weren’t, but also taking the lead back the other way. I think all of those roles have been very valuable.

- I think being there to connect people worked really well. Being there to say ‘oh, have you spoken to this person, did you know…’ I think that worked really well.

- [And do you think having me here in the community doing what I was doing helped at all?] Yes because you managed to get stakeholders together, who probably would not have made a situation to come together on their own, by being a neutral party, third party.

- I would say what’s come out of it is linkages. You made us aware more than anybody else of what other people were doing, of initiatives and you put people into contact with each other. For example, if it wasn’t for you, we would probably never have met Beth Fulton and it’s certainly been very valuable connection. Not only is there ongoing data exchanges between her and us, but Beth’s also given us a letter of reference for the turtle program for grant applications. In Beth’s letter of reference, she said how valuable it was to have the Gnaraloo data available to feed into her model. So we think it’s very important to have somebody of your calibre continuing in the role but it’s…really needs a person that can make linkages between others and make the one industry stakeholder group aware of what others are doing. Then it’s up to them if they want to run with that. It’s to make bridges between grain silos.

- [So rather than me actually transferring knowledge you saw me as facilitating it; is that correct?] Yeah, for example you let other people know about us, you let us know about other people, you brought other people to us, you let us tell our story to you and in that way our influence, knowledge and awareness increased rather than decreased which was very valuable because we’re on the ground and don’t have the resources to move or work in arenas that you access, and through you, we could get information when we needed it. It felt inclusive, not exclusive. [And did that result in any changes in how you guys were doing things?] It’s difficult to say Kelly because, for example, you gave us Beth Fulton. This came out of that. So then it’s up to us and Beth what we do once you put the link in front of us to each other. If we don’t follow up on it, then we can’t complain about anything. If it wasn’t for somebody like you, then we possibly would never have crossed each other’s paths.

- [In terms of my role, what do you think, and feel free to be completely honest here. Do you feel that that had an impact on things that have happened here in one way or another?] Yes, it is definitely helpful to have that contact point, if you like. It’s like a central contact point that can connect you to a variety of avenues. And I guess that’s what we hope that our research group can do, and when we do build the Ningaloo Centre there might be the facilitator in there for the research who would be able to be that contact, especially in the research side of things. So you’ve got that point of contact – whereas you’re not looking after one person’s interest – it’s not about UWA, it’s not about AIMS or CSIRO, it is a point
of contact where all the research and all the bodies can be reached. So I think that’s very helpful with the connections.

8.2.2 Drawing regional stakeholders together

- The capacity to draw people together within the region was excellent and the setting up of that reference group. I don’t think too many other PhD students have actually managed to do that in that kind of situation, or I would have expected in that situation. That’s probably because you’re coming out of consultancy as well, you’ve got more experience than a lot of the PhD’s. Probably, if there’s…I’m trying to think, trying to remember back …

- It’s been about making connections and communicating with each other and knowing, so that everyone understands what each other is doing and what our ultimate aim is — rather than us all working in our own little silos. So your role has been helpful in that, I think.

8.2.3 Persistence of networks

- [Me coming here, doing all the stuff I did, then leaving, and now I’m leaving for good…what are your thoughts on that?] I think even if there are no more stakeholder groups, just having that openness will work until positions change and there’s new people in the seats. [So, the networks that were established, have persisted…for now?] There’s certainly persistence there, but as people change jobs etcetera, that could fall apart. Because it doesn’t appear that anyone’s specifically taken over that role. [So, it would take someone, when new people come in, to keep those interactions going?] Yes. And that’s where you start to get problems. Because if someone else takes it on then their objective agenda would be perceived as being the reason for the meeting. An independent person hasn’t got that agenda, but for example if CCG took it on, people might not be as likely to come, thinking this is a CCG thing, not this is a stakeholder group. [So, people perceive me as fairly neutral party?] From our perspective, that’s how we see it.

- [I was here for 18 months, and then I left. I was gone for over six months. Does the project still have merit? Have those connections persisted or they…?] The connections have remained, only chiefly I think because we have built some relationships with the scientific people, so that kept connected. And also because we’ve established the reference group, having someone like [the research coordinator] has been helpful, he’s been a point of contact and someone to sort of say ‘we need to talk again, we need to get together, there’s a few things to talk about’ and that’s been really helpful. But you do need someone who’s driving that. If you’re not there then someone needs to be there. There needs to be a reference point. [And do you think that person, rather than being affiliated with a particular agency, being independent …] I think that’s ideal. Yeah, I do. And I think that’s where perhaps that person might be based at the Ningaloo Centre eventually. They’re community based, they’re interested in the region, the community and connecting the community – and that’s the important role.

- [One of the things I’m interested in was whether…because from my understanding, not much really happened with the reference group after I left despite plans for otherwise; was whether or not those relationships persisted without having someone coordinating the interactions.] Yeah. They certainly persisted in a far more informal basis and a far more irregular basis but I still feel a whole lot more comfortable about ringing up one of them and saying what’s going on with this or have you heard about what’s going on here. It’s just, yeah, it’s the initial handshake to open those doors and that’s invaluable.

8.2.4 Connecting researchers with locals and local concerns

- [So, if the researchers had just tried to come up and get their information out, if I hadn’t been here in this role, what do you think would have happened?] Oh, they would have been between a rock and hard place. Who would have acknowledged them? For a starter they wouldn’t have been sitting in my lounge room having lunch. They would have found it extremely hard. It would’ve been hard. I would say that they probably wouldn’t have had presentation nights, they might have had it, but there might have been three, four, five, ten people there at the most. [So, why do you think that they got the turnout that they did?] I think from interest, obviously people are interested, your input. I know that there were probably seven or eight people, probably more but I know of eight people, that were there because of
you, yourself and what they've listened to you speak about and part of your job. So, they've gone with a genuine interest in, and there was probably more, I don't know, but I know of eight that were there for those reasons, yeah, definitely.

- but I think having you in the region improved our engagement with the region, I would say that. I think it gave us a much better insight into what the local community was thinking, in particular it was very helpful to engage with people about what they wanted to see in the presentations – I think that was really important, because it gives people a sense that we're addressing some of their concerns.

- I don't think most modellers would have anticipated that the Gnaraloo road would be so important for Carnarvon, for instance, it was a controversy that began after we started the modelling project. But it was identified through, I think, your discussions with people and then we were able to build that into the model and the final desktop tool that people were given. It did come up because of your engagement. So there’s that side of things.

### 8.3 Communicating knowledge

#### 8.3.1 Taking time to explain the research

- And it’s a known fact and I've said it to everybody that if it hadn't been for you I would never had had my eyes opened, because here's somebody that comes from another country, another part of the world, with the knowledge that you’ve got – even though you’re trained in that thing – who has more interest than what I had. And this is my community, I live here, it's my own. So, that, I think, was one of the big things: being around somebody that was very aware of what was happening and was prepared to spend the time to tell you and explain it to you, which makes it so much easier for people, for layman, like we are. Even though I've been in the boating and fishing industry all my life, you do get very closed off to what happens out there because every day you go to work and you think it's the same thing, day in day out. When it's really not and things are happening that you're not really taking a lot of notice of. But, when you come to be around somebody that’s fully aware of all the things and looks sideways at things, it really does open your eyes...[So, you’re talking about marine life and things like that?] Marine life, the environment, the way people think about the environment, the tourist side of things.

#### 8.3.2 Opened eyes to what’s happening in region

- [do you think that having me living in the community, doing what I was doing, helped at all?] Oh, definitely, tenfold Kelly, tenfold. I’m sure I am one of many people that have had their eyes opened and their minds opened up to what actually is going on in the community, where the community could be going and I think what you’ve done is give, for me anyway, is given me another way of looking at things. Because I think most people, and maybe I’m wrong, grew up with in a town like this thinking there’s nothing wrong or nothing happening out there because it's just a day by day. I can go for a swim, I can hop in my car, I can go for a swim when I want to, I can go and drop a line in the water, I can go and shoot a fish or whatever. So, with that attitude, life’s great. What's happening? There's nothing happening here. But really the underlying current is there’s a lot happening and without people like you that come and live in our community and actually get involved with the community, a lot of people, I certainly wouldn’t be aware of, I am aware of a lot of things but not aware of a lot of things...[Do you mean the sort of pressures and the change...] Yeah. The change and having the tourist cycle and things like that explained to you. Because, even though I'm like you, I've been all over the world, I looked at tourism in a different light when I was away, I looked at how can I improve tourism back in my community and what's the difference over here, what makes this work and why it doesn’t work here.

#### 8.3.3 Using local information networks

- I think the other thing that was really good from our perspective, was making use of local information networks when we were doing promotions and running things, it was very helpful, and that's something that I’d definitely try and do in any future projects which are large enough, I guess, it all depends on the purpose of the project, but if you’re focused on uptake, then you should have that.
8.4 Facilitating/driving

8.4.1 Driving action

- [do you think there was any benefit of me being up here, living in the community for all of this?] I think you started setting our meetings and you introduced me to a new group. I still remember, although we didn’t get anywhere, that we had those planning sessions with [names] with a whiteboard, I don’t know where things went but doing that planning, where we are and where we are going, who do we get involved and how do we get information out. I personally like those things and I think they’re very useful.

- I’m just not sure about where the ownership sits. While you were here, you were the driver but as soon as you went back to Canada, things sort of slowed down a bit. I know [name] has been trying to tick things over but there hasn’t been any meetings until today, since you’re back again. So, yeah, in terms of your role, you’ve facilitated certain meetings that were very useful for me. Things not happening with you being away shows that your role has been very useful.

8.4.2 Influence on meetings and presentations

- I think the way that we ran the meetings in the region was a big improvement. Your own skill set was, I think, quite important in terms of improving the presentations and making sure they were clear, certainly for me, possibly less so for Beth because I think she’s probably a clearer communicator that I am in general.

8.4.3 Generating interest in the region

- Very good, very good in the region at generating interest and getting people to ask new questions, new things – I think that was really important.

8.5 Providing regional input to NRP

8.5.1 Regional input for communications plan

- I think the other areas where you’ve probably made a big difference was in the [CSIRO/NRP] communications plan, and just constantly hammering them to actually pay attention to people in the region.

8.5.2 Management committee meetings – providing regional context

- So there’s that side of things. I think the other interesting thing was just having you in on the Research Cluster’s management committee meetings. I think that pushed the meetings in a slightly different direction than would otherwise have been the case. Because the people who were actually engaging with the regions were probably myself, Beth and you really, in terms of the communities anyway, and the people and the politicians. And I was the only person on the committee who was doing that kind of regional engagement, Beth didn’t have the time, so I pushed it in effect but certainly having you there as well, you’d talk to me before and after meetings and we’d call Neil and get him to, push his thinking in slightly different ways, and that was I think pretty valuable for the cluster as well – so that they weren’t just delivering four research projects, we were actually a bit more focused on the communication side of things. So just making sure that people who weren’t in the region did know what was going on.
8.6 Issues

8.6.1 Agency sensitivities

8.6.1.1 Handling concerns in Perth over reference group

- When there have been issues, the issues have been with the upper level management, DEC and their capacity to grasp what it is you're actually doing. So even though you've spoken to them, somehow...Somehow they needed to be more hooked in to that, and I guess, just awareness of their sensitivities around what goes on in the region. For instance, the regional reference group when that was set up, that was probably the thing that caused the biggest stir. So maybe you needed to take a few more people with you, but in the end it got there, and that was through the work of Neil, he was pretty good at bringing them around and assuring everybody.

- [Do you think there is anything I could have done to avoid that or minimise the issue?] It's hard to say. I mean, they might have shot you down at the very start if they had of heard about it at the beginning. But what you almost need to do is get that on the table at the very beginning of everything and into people’s thinking at the start. But having said that, I think for you it was kind of an emergent process in the region. The only thing we could have potentially done differently is just get it on the agenda from the very beginning so at least it's in their mind that it's something that might happen. But then it becomes about control, and with the way that DEC does it, it would have been a select group of people who wouldn’t have had the same kind of networks that we needed.

- I think the only thing that could have been done differently is that there’d been ongoing discussion [about the reference group] before it happened. [More contact beforehand?] Yeah. ‘Cause I think it was…it knocked everybody, it was a surprise to everybody, it was like shit, where’s this come from. [Because it didn’t occur to me that I would get that reaction. I don’t know why, but I just didn’t.] It seemed perhaps you’d had discussions with the Research management committee and those guys and were aware of what you were doing. So, something broke down there.

- And perhaps it just didn’t click [as to] where it [reference group] was going or how it was going to flow out in the community or how it was going to flow out on the ground. So, and I think even some of the research coordinators, the professors and things that were coordinating components of research have expressed to me that they were surprised where it came from. So, I think some parties were well informed, all parties might have been well informed but some parties obviously missed some particular component of it and didn’t pick it up and I don’t know how to improve that, apart from having earlier and longer discussions. But I don’t know what actually happened.

- It probably was a little bit turf-territory going on there like I indicated that some people probably presumed it was their responsibility and to have someone else coming in and saying well, this is how we’re going to try and get it to work they probably went, well, what’s going on?

- [So, probably a little bit more, maybe more personalised contact with those people would have helped?] I think personalised contact and personalised opinion from those guys, you sitting down going, ‘look, this is really what we’re keen to do and how we’d like to role it out, what do you think?’ I know it sounds easy and I’m sure you did have some of those lead-in conversations but, yeah. [I had quite a few conversations with science people in Perth, but then when I moved up here I just didn’t have as much contact, personal contact with people down south] Yeah. I don’t know how you do that sometimes, it’s just, I think sometimes you can do everything you should do and still people miss some particular point or some particular angle on the way it’s looked at and get offside. That was obviously an issue for a little while there. I guess it was overcome quite quickly but...

- Obviously you had concerns with the Department as well in terms of involvement of Chamber of Commerce which was out readily negative towards what we were doing in terms of the world heritage listing. So, naturally some of those suspicions arose but I don’t think you could have done...you wouldn’t want to not include them, so I don’t know what you could have done differently to alleviate that problem, that’s just the nature of people interactions I think.
8.6.1.2 Stronger links with head offices in Perth

- So, probably try to develop some stronger links with our head office people like the Marine Science Research Coordinator, it would have been great for her to probably be here and in attendance at some of those discussions. I think [there] may have been some of the politics in the background or concerns in the background as well, I’m not too sure. But, I think that would’ve been really valuable ‘cause in essence she had a link to so much data and to be honest I… whilst we’ve got some access to it, it’s still not easy to access or still not in a day to day usable form.[I think in November the final reports will be coming out.] They’re still coming but it’s been a couple of years now, so you’d like to think that it’s going to flow out.

8.6.2 Distrust of the position

- I think there has been a distrust of the position amongst classical regulatory bodies, who I think were partly threatened or questioned ‘why is this person doing this, who do they think they are’ kind of thing. I don’t think they saw all the value as much because they weren’t at the coal face actually working with it, they were sitting further up, they probably assumed a greater degree of connection than was really there or assumed that if the connection wasn’t there then it wasn’t important. I haven’t seen the outcome of [redacted]’s new ego diagrams as yet. He does say they’re a lot more connected than the original ones which is good. I assume that there’s a fairly large, not just [redacted] node in there anymore, but the Kelly Chapman node as well.

- I guess that’s one thing is that I was initially suspicious of the motives of what you were doing just because I work for the government I’ve got to be so careful about what I say and where it goes and all those sorts of things, you just need to know what’s been, what the motive of the whole process is and I guess I was in a slightly harder position having only just come back into the district and not having a full understanding of how our information dissemination process was or wasn’t supposed to work within the department and there was that initial conflict of it doing what we were trying to do and whether this group was complementing it or conflicting with it or…I was sort of stuck in the middle of that concerns from Perth a little, just going, well, shit I don’t know what, who do I talk to and who, how does this all work?

- [Have your concerns been allayed and, if so, how?] As I say, there’s still some concern there because it was a research project on your behalf but I think just over time the relationship’s developed between us and the other parties, I saw that there’s a whole lot of other benefits that are coming from it so, I still had those voices in the back of my head saying be careful what’s going on make sure that it’s been done for the right purposes, but the confidence was given by the membership involved and by the discussions that we had. So, yeah, I guess it’s just time.

- The process was probably a little tainted by those two things, firstly I was new but also my concerns or suspicions or whatever it might be that it was coming from a research perspective. [What was it that actually allayed some of those suspicions and concerns, assuming they were allayed?] Some of the concerns are still there a little and I guess I still see it as being a process that you are going through for your PhD and once that’s finished you’re going to walk away and the deal’s done and no more interest shown and that’s, once again, not against you, just against any research, well it’s typical of the researchers…they come in and do their work, stir up all this stuff and then disappear. So, I guess we’ve always got those concerns. What did you actually ask me?

- [Do you think there’s something I could have done, that I didn’t do, to mitigate against that feeling that I was stepping on agency toes? Is there something I could have done to help avoid that?] I don’t think so. I think the fact that in this particular case it was related to your research, I think it was always going to be in the background that the primary purpose of this is Kelly’s research, the secondary purpose is to get the information out. In a world where the research isn’t happening in the background, development of that reference group and the way that you did it would have been ideal but that would have been you as a member of the community or working for GDC.

- [Were there concerns that I have an agenda with my research?] Yeah, I always saw that there was some agenda behind it and I don’t think that that could be avoided whilst you were sitting in that particular position. Whereas if you’d walked in as working for GDC and said this is what I want to do, I
guess I probably would have seen it perhaps there was a GDC agenda there as well and I would have been suspicious of that, but probably in slightly different ways.

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  [Was the concern around my agenda ‘oh she’s going to be checking up on us’, or was it something else?] Look, in essence, I saw it as potentially assessing our effectiveness in terms of what we’re doing and obviously I’m always going to be a little well, how is this going to reflect on what we’re doing. So, yeah, I think it was a checking and I guess for me that’s always an acknowledgement that we weren’t going to be able to do it as good as it could be done in terms of getting information out there. [For the agency?] Yeah. And there’s other ways to do it.

8.6.3 Toe-stepping

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  But over time just based on those discussions and the interest that was shown, I started to realise oh, perhaps there’s a better way of doing things and this was one of those better ways of doing things and sharing the load around and taking away from that DEC control type position. [So, was there a bit of a toe-stepping concern?] Yeah, definitely. I was concerned but that’s probably, a lot of that was due to my lack of knowledge about what had happened over that period and how that information was supposed to flow out and those sorts of things. So, I’ll use my absence as defence in that case.

8.6.4 Action research is a foreign concept

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  I think also even just the concept of action research was so foreign to biophysical scientists, because it is so different to in terms of you won’t tend to get involved in that system, you won’t change the system, you’re there as an observer, but that part of it was certainly a new experience for people like and I as well.

8.6.5 Lack of mandate

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  [Was there anything about me that didn’t work?] The only question I had was what was your mandate? I could see that you’re facilitating with us as part of your PhD research, but say an officer from the Department of Ag comes to us, talks to us about Rangeland condition and required monitoring and states that they are going to have some facilitating role between industry and Government. We know they’re acting on the authority and mandate of Ag who have a certain legal responsibilities and obligations to achieve certain outcomes.

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  I think this issue of mandate is important, so that change may be brought about as a result of your involvement and facilitation. It’s fine talking with each other, but it ultimately has to result in change…. …I can’t see the role being for a Shire, but if it was for a Development Commission or something like that and it a role where you help people cross paths with each other for good things to come from that and you helped to facilitate that, I think that would be very good. And certainly under the current Royalties for Region State Government program, in terms of community engagement, there should be avenues for funding for a knowledge transfer facilitation role like that.

8.7 Positive attributes

8.7.1 Outgoing

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  I think being outgoing certainly helped.

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  that willingness to approach people, to not be intimidated by who the audience is, but that this is someone who might be interested in this information, and taking time to explain the value of the information.

8.7.2 Knowledgeable

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  I think being knowledgeable about broader environmental and science issues helped.
8.7.3 Professional

- [what was it about me or what I did that worked or didn’t work?] The qualities that make someone, effective: professional, and not trying to be emotionally persuasive. One thing that’s very detrimental is when people start trying to convince people of their argument rather than just presenting it in an open forum.

8.7.4 Neutral/outsider

- [And do you think having me here in the community doing what I was doing helped at all?] Yes because you managed to get stakeholders together, who probably would not have made a situation to come together on their own, by being a neutral party, third party.
- [So, it would take someone, when new people come in, to keep those interactions going?] Yes. And that’s where you start to get problems. Because if someone else takes it on then their objective agenda would be perceived as being the reason for the meeting. An independent person hasn’t got that agenda, but for example if CCG took it on, people might not be as likely to come, thinking this is a CCG thing, not this is a stakeholder group. [So, people perceive me as fairly neutral party?] From our perspective, that’s how we see it.
- I think the value was that it was an independent person who didn’t have an agenda, except to share the information; I think that was the value rather than having someone who’s already had a certain objective that they were trying to meet.
- [And do you think that person, rather than being affiliated with a particular agency, being independent …] I think that’s ideal. Yeah, I do. And I think that’s where perhaps that person might be based at the Ningaloo Centre eventually. They’re community based, they’re interested in the region, the community and connecting the community – and that’s the important role.

8.7.5 Connected/available

- [What do you think were my attributes that perhaps helped or hindered me in that role?] Well, I think you’ve been available and that’s been very helpful and I do believe that we’ve been able to utilise your talents and connections to get some good results and some good…I keep saying ‘connections’, you know, but that’s what it’s really been about.

8.7.6 Social science background

- Let’s just say the one distinguishing factor about you is that you do have asocial science background or perspective or approach which does put you apart from others. I don’t understand it, right, it’s not my field, but I really see the value it adds and I wish more people like you would be engaging with us. Not just us at Gnaraloo, people like you should be working with DEC, the pastoralists, everybody…everybody that struggles with communication.

8.7.7 Communication skills

- [What do you think are the attributes that worked for that role?] Very strong communication skills. I just had an hour long interview with Tod Jones about the Ningaloo World Heritage listing and about the consultation that was done for that, and my point to him was that really it’s not something that an engineer is that skilled to do. Just like I can’t have a go at fixing at diesel engine, it needs to be somebody who is not only trained and skilled in communication, but also has a feeling for how to communicate differently with different stakeholders to be inclusive.

8.7.8 Willingness to share knowledge

- [Is it interpersonal skills, or is just a sense of interest?] Oh, interpersonal and knowledge. The thirst for knowledge from somebody else is always a factor. For me, somebody like you who is what I consider an academic, that in itself is a form of friendship because you’re sharing something that I don’t know anything about with me. Where you don’t have to, nothing’s forcing you to give me that information. You’re giving me that because that’s what you want to do and I’m asking you, but still, you don’t have to give it if you don’t want to.
8.7.9 Qualifications and skills, personality, neutrality & openness

• [what was it about me that worked or perhaps didn’t work for that role?] One, I think if you had the qualifications and skill set, technically you actually knew what you were talking about. Two, you had the personality and style and Three, you didn’t bring vested interest or, if you had vested interest, you kept it at arms length. I felt it was a neutral, open reception for ideas and discussion and that our views would be considered, that it wouldn’t be discarded or altered or influenced by your personal views. We saw you as committed to knowledge transfer and facilitate that without interfering.

• [you mentioned my personality and style; do you want to elaborate on that a little bit?] When I have to appoint the turtle teams every year, I assess technical ability, previous qualifications, scientific training and experience, but then I use my gut and instinct to go for the right personality fit because sometimes people have been outstandingly qualified, but I don’t give it to them because of communication issues, they just don’t have the tone, style or manner. I think this is what’s so difficult for an interview panel appointing someone in your role: you can’t just quantitatively assess a candidate and give five points for that, ten points for that, one point for that, and then appoint the highest scoring candidate. You really have to have somebody that can work with people and can be firm when they need to be firm, soft when they need to be soft, technical when the process needs to be technical, conversational when its called for. I think it’s a mistake to just approach these things as quantitative or engineering style conveyances of information. The skills, qualifications and communication styles of social science come into it. Communication really is an art, not a just a science! And it’s all the things the scientists hate, having to communicate extensively with different groups of stakeholders. Even I don’t like it, but I certainly see the value in it. It’s just harder to deal with because it’s so nebulous and intangible.

8.7.10 Listening skills

• I think one thing about you is that you’ve got good listening skills. You don’t talk at us, you communicate with us and dialogue with us. Our position has always been that we’re don’t want our point of view to dominate or to necessarily hold the day, but at least when we communicate with you, we feel our views being included in the decision-making process.

8.7.11 Caring about region

• Because you were particularly good in your role, we participated a lot with you where normally we wouldn’t invest so much time because it’s yet another PhD student needing to do research where we get no return out of our investment of time and resources. In cold, hard dollars and time value, many, many, many PhD students want us to participate with them, but the time we spent with them, means we don’t spend time on other important things that the business needs on any particular day. [And so what was it that made you change your mind in my case?] It’s your personality and communication style and I think we also got a feeling that you were not just solely motivated by personal gain and that you were not just solely doing this to get your PhD. You actually cared about the region, you wanted the best for the region, you wanted to invest and contribute. We see value in that and in somebody like you, somebody in a role like that would greatly add value, but it would need to be continuing. I couldn’t even tell you for what Government Department (if it was for a university, again the issue is what’s the mandate to be able to bring about change on the ground?) Maybe it would have to be for a Development Commission.

• Without you coming in to Exmouth and me not meeting, that’s not to say I wouldn’t have had some of the same beliefs that I have now and probably stronger but being around somebody that is world minded about the things that go on, not only here but in the world and having those explained to and feeling very strongly about it too. That’s a really big thing with you, is that here’s somebody that does all this that actually genuinely cares about what she’s doing and comes across like that. Whereas some people and a lot of people that I’ve talked to and I’ve had a lot of so called educated people on my boats over the years, they’re interested in doing what they’re doing and they’re not sharing or don’t show a great deal of the caring side of it, whereas I believe that somebody like yourself who does is welcomed into the community with open arms even though it takes a little while. [So, in terms of some of my attributes that helped, so you’re saying this attitude of caring, caring about the environment or caring about the community?] Caring about both. The environment, the community and the people that
you meet. I think in your case it’s a genuine thing, I see you and I know some of my friends see you as a genuine person ‘cause if you weren’t you wouldn’t get the time of day. But, because of that it makes it easier for people like myself to understand what you’re trying to get across. [Do you think that these are the same attributes that hindered me, because maybe people don’t see me as neutral or other things?] Oh, no. I think, well, you’re always going to get that anyway …but on the negative side of it, I’ve got to be honest with you, I’ve never heard anybody speak negative of you at all.

8.7.12 Being genuine

• [And you think that, if I get what you’re saying, me being so passionate about my topic helps]. Definitely. [Does that make it infectious or does that]…I think a certain amount of infection comes off there, yeah, a certain amount of that. It’s just, and I think one actually believes with you after a while that you are genuinely, you are a genuine person and you genuinely believe that what you’re doing is the right thing. And I think that comes across probably more than anything, which…[So, even if people disagree with what I’m saying?] Yeah, which endears people to you, I think. Because they’re prepared to go well, ok, well, even if I don’t necessarily agree with Kelly, at least she’s got a point of view and I’ve got mine but it doesn’t affect that relationship. But, they’re still prepared to sit there and listen to what you’ve got to say. [So, there’s something about saying that we can agree to disagree, is that it?] Exactly. And that’s probably why I’ve never heard anybody speak ill of you because they, for that simple reason, that ok, I don’t necessarily believe in a lot of the things that Kelly pushes, but I like what the girl does. I like the way she thinks, she’s prepared to share so, and they’re all qualities that hopefully most people would enjoy in somebody.

8.7.13 Fitting in

• I’ve never heard anybody speak negative of you at all. There might be some out there, but certainly in my travels and the people that I’ve talked to, a lot of that might be about well, [●●●]’s really friends with her. But, most people that I know pretty well know me and will speak openly to me anyway and if they don’t like something, they’re going to say it. But, I personally definitely haven’t heard that. Definitely. [So, why is that, do you think?] Oh, I think because certain people fit in and certain people don’t. And right from the word go, I mean, you were, from the time that I met you, you’re a very easy person to be around, you were very easy to have conversation with. I mean, you spoke to all the people that I introduced you to, very openly and forward and truthfully as far as I know. So, that in itself is a big thing and I think people warm to that too.

8.8 Negative attributes

8.8.1 Lack of sensitivity/ Bluntness

• The other part, the part that didn’t work so well, I’m not sure if it just didn’t work so well or actually it’s just Canadian/Australian approach to life sensitivity, there were a couple of times when you probably went in a lot harder and a lot more upfront than I think an Australian PhD student would have. I’m not sure if that’s personality or background or, and I can’t say that it was wrong, I wouldn’t say that you damaged the relationship at all as a result. I’d say there’s probably some cases been a benefit that you’ve confronted them enough that they have done something. It just wouldn’t have been…it’s a bit more…it’s not as as over the top as a US approach but it’s certainly more upfront than typical Australian approach. So I’d say that was the biggest difference, I wouldn’t necessarily say it was a bad thing. I just don’t have any evidence either way. It’s just that there were a few uncomfortable moments where ‘oh, I wouldn’t have said it that way’. But like I said, I don’t think that was necessarily always a bad thing.

• Like I said, and I don’t think the cultural or personality or whatever it was, background, that just made you a bit more blunt. Not sure that hurt, like I said, it was certainly just different. A couple of situations I think a more gentle approach might have been slightly more forthcoming in the short term, but whether that really would’ve had as good an impact in the long term I’m not so sure. I don’t think a timid person that was easily led or over-spoken would’ve actually done as well. I think you did have to be a bit out there to get their attention and not be overwhelmed by the situation.
• [And is there anything I could have done differently that you think might have resulted in a better outcome?] No. Like I said, there’s a couple of things that on a personality level I probably would’ve approached slightly differently, but can’t say that it would’ve actually led to anything better. Some instances I think probably would’ve led to something worse because they would have just, a more gentle approach might have been actually ignored. There were a couple of times where you had to push them to really think about what they were doing. In the short term it led to some cranky comments, but in the long term those were the people that came round the most. So, as I said, I’m not sure it was a bad thing, even though there were a couple of tense moments as an immediate result. [So your impression isn’t that it was a permanent alienation that resulted?] No. No.

8.8.2 Not part of community

• In a world where the research isn’t happening in the background, development of that reference group and the way that you did it would have been ideal but that would have been you as a member of the community or working for GDC.