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***ANALYSIS OF AN ECOTOURIST BASED MANAGEMENT
STRATEGY***

***CRYSTAL CAVE, YANCHEP NATIONAL PARK, WESTERN
AUSTRALIA***

CHARLES PRIDDLE:

**In partial fulfilment of a Bachelor of Arts Honours
In Geography (Environment and Resource Management)**

**On exchange to *Edith Cowan University* at the School of International,
Cultural and Community Studies**

Date of Submission: November 7, 2000

USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

ABSTRACT

Ecotourism has quickly become one of the most influential and prominent terms used within the tourism industry today. With its many obscure definitions ecotourism has also been used to support a great number of unsustainable tourist developments.

This study examined whether ecotourism had the ability to ensure ecological and financial sustainability through increased public exposure and appreciation to an ecologically sensitive area. One place in which this notion is being put to the test is in Crystal Cave, a popular tourist destination inside Yanchep National Park, 50 kilometres north of Perth. This cave is named after the beautiful reflections off the groundwater pool within the Cave. However, tourist numbers have dropped in recent years due to the diminished aesthetical appeal of this cave as a result of the lowering of the groundwater pool. More importantly still has been the discovery of a new amphipod life form living within the groundwater pool of Crystal Cave. An intense effort is now being made by government agencies to save the species by artificially rejuvenating the pool within the Cave until its original levels can be restored through water conservation measures.

Instead of excluding tourists from this environmentally sensitive area during the project, an ecotourist based model has been developed to increase tourist numbers, and therefore revenue, in order to subsidise a majority of the project. If properly managed, this ecotourist based management model has the ability to provide an exceptional example

of an ecologically and financially sustainable project payed for by increased public exposure to an environmentally sensitive area.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

- (i) incorporate without acknowledgment any material previously submitted for a degree or diploma in any institute of higher education;
- (ii) contain any material previously published or written by another person except where due reference is made in the text; or
- (iii) contain any defamatory material.

Name: Charles Priddle

Signed: _____

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Finally, I would like to thank my parents. Both have been an inspiration to my educational career. Had it not been for them, this thesis would have never been developed.

DEDICATION

This paper is written in loving memory of my father, Dr. George B. Priddle.

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1.1 BACKGROUND TO THE STUDY

The concept of ecotourism is rapidly becoming one of the most discussed topics within the tourism industry. Government agencies, industrial organisations and members of all levels of the tourism industry have adopted ecotourism as a method of marketing to today's increasingly ecologically conscience traveller. Unfortunately, problems with the exact interpretation of ecotourism have resulted in nature based developments not always adopting sustainable tourism practices. As a consequence, this has led to occasional degradation of the environmental resource involved.

Prior to 1990, definitions of ecotourism were quite vague and often encompassed any tourism activity that included the natural environment. Such activity was to cause minimal environmental impact. Entering the 1990's, the Ecotourism Society developed what is often considered the first comprehensive definition of ecotourism in a political arena as "responsible travel to natural areas that conserves the environment and improves the well being of the local people" (cited in Honey, 1999, p. 6). More recently, researchers are still continuing to concentrate on effects of ecotourism to the local people, particularly as much of today's ecotourism occurs in the Third World. Often included in these definitions of ecotourism are such ideas of empowerment of the people and respect for local culture (Honey, 1999; Mowforth & Munt, 1998).

However, as this research takes place in an Australian tourist site context, there is a need to concentrate on a definition that recognises locally prevailing social, environmental and economic conditions. Less significant concentration needs to be put on such issues as multinational ownership of resorts or displacement of local people. In developed countries, such as Australia, political and social aspects of tourist developments such as these are often dealt with through social norms, as well as laws and regulations. Having such socioeconomic problems taken care of, interest can be better developed in topics such as financial sustainability and education of tourists. With this in mind, a following definition used by the Ecotourism Association of Australia (EAA) will be employed. In this study, ecotourism is "ecologically sustainable tourism that fosters environmental and cultural understanding, appreciation and conservation" (Commonwealth Department of Tourism (CDOT), 1994, p.3).

The EAA's definition is appropriate for this study because it not only focuses on projects that are ecologically sustainable, but also projects that are financially sustainable. The term 'financial sustainability' in this definition has been interpreted for my thesis to be the promotion of conservation efforts, that increases tourist dollars through an ecotourist based management strategy, aimed at visitor understanding and appreciation. If visitor appreciation is effective enough to bring needed funds through return visitors, or positive word of mouth, the project will be considered financially sustainable.

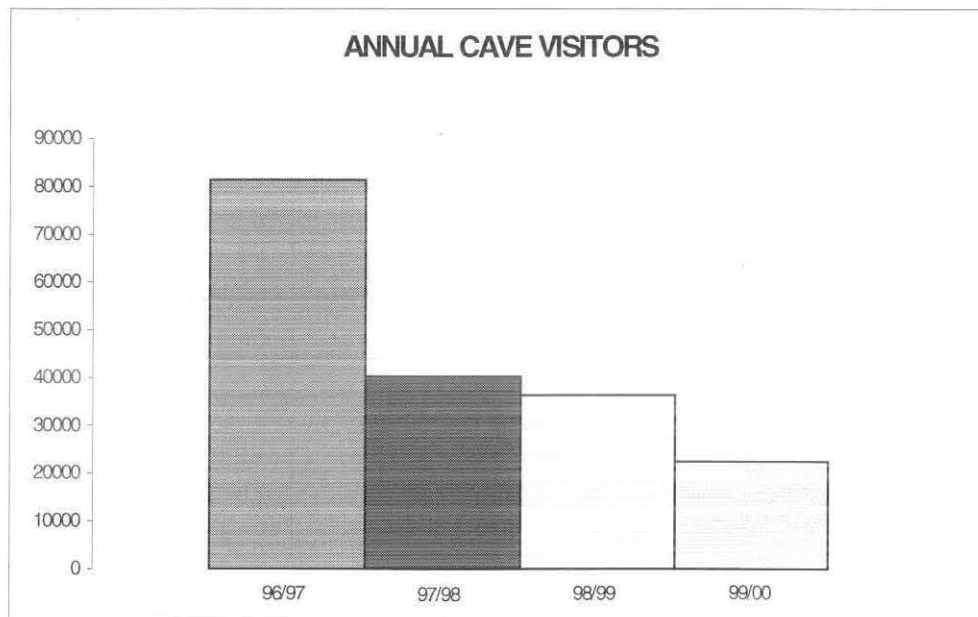
One particular place in which an ecotourist based model is currently being developed is in Yanchep National Park (see Figure 1) at Crystal Cave (see Plate 1.0). Being one of several caves within Yanchep, Crystal Cave is the most important tourist cave in the Park and in fact has the highest visitation rate of any cave in the State (Department of Conservation and Land Management (CALM), 1989, p. 151). Open to tourists since early in the beginning of the twentieth century, Crystal Cave was named for the spectacular reflections from the stalactites off the groundwater fed lake that found within the Cave. However, water levels within the Cave have been dropping drastically since the early 1990's. Reasons contributing to such a drop in water levels of the groundwater within Crystal Cave include a series of excessively dry winters with low rainfall, enhanced by a depletion of the groundwater by pine plantations and poor extraction management (Hillman, 2000, p. 7). As water levels within the Cave continue to drop, so does the number of tourist that were drawn to the aesthetic values of the Cave, particularly its spectacular water reflection (see Table 1).

TABLE 1

TOURIST VISITATION NUMBERS TO CAVE, 1996-2000

DATE	ADULTS	CHILDREN	FAMILIES	CHARTERS	EDUCATION	TOTAL
96/97	36066	12846	0	14318	3400	81365
97/98	24163	8477	0	4653	2974	40267
98/99	21242	7815	0	3860	3383	36300
99/00	11783	2470	1408	3884	2897	22442

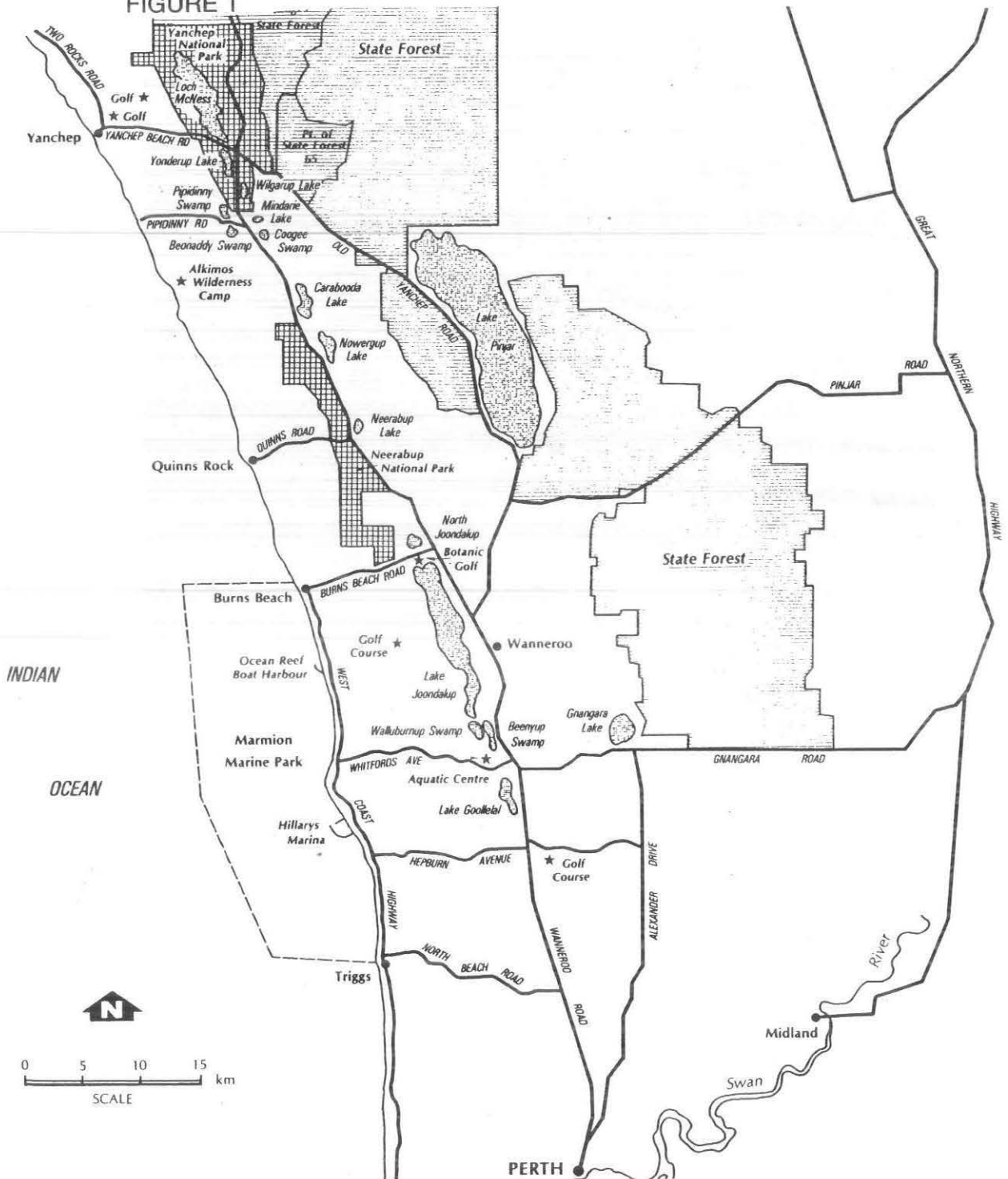
Source: Yanchep National Park: Park Managers records



Source: Yanchep National Park: Park Managers records

More important than the declining number of tourists visiting the Cave, is the importance of the water inside the Cave as the habitat for a small aquatic amphipod endemic to Crystal Cave. These amphipods are the only ones in the Park that do not live off the nutrients brought into the Cave by the roots of the giant tuart tree, *Eucalyptus*

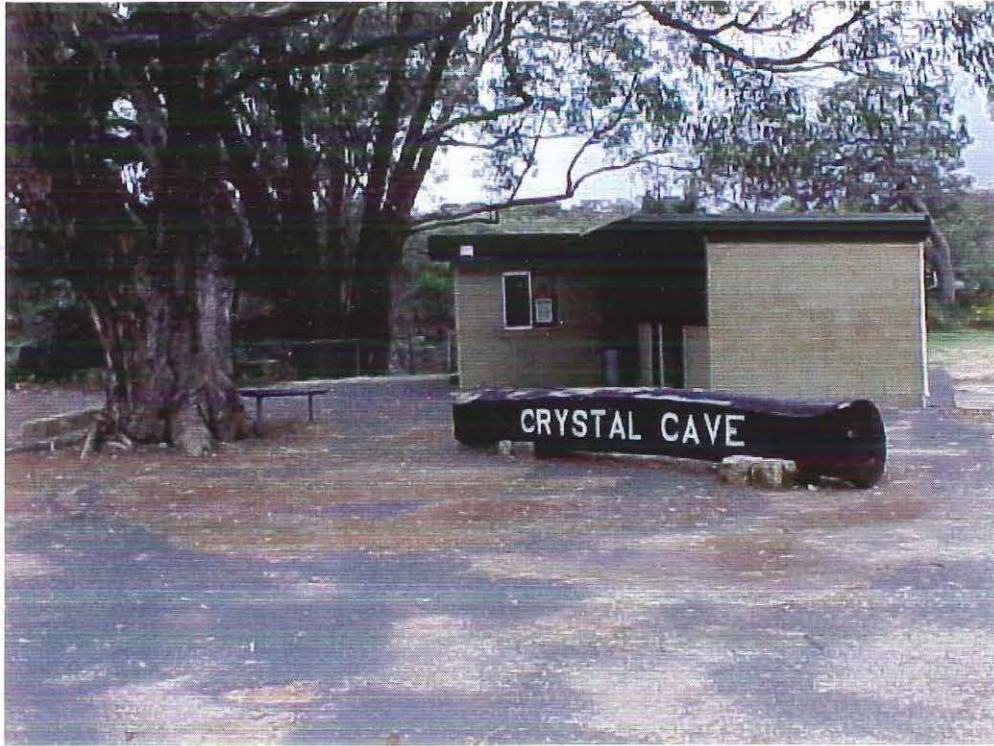
FIGURE 1



YANCHEP NATIONAL PARK LOCALITY MAP

Source: Department of Conservation and Land Management. (Ed.). (1989).

PLATE 1.0



ENTRANCE TO CRYSTAL CAVE

Source: Author

Plate 1.0: This photograph shows the entrance and kiosk to Crystal Cave in Yanchep National Park. (15 September 2000).

gomphocephala, and without the ability to migrate from the Cave, they remain trapped in the drying pools of the Cave (Anthony, 1999, p. 7). Any further drop in water levels could easily result in the disappearance of this newly discovered and relatively unstudied life form. An intense battle has now begun to save this new species. Instead of closing this ecologically sensitive area to tourists, the Water and Rivers Commission (WRC), along with CALM, and its staff at Yanchep, have decided to develop an ecotourist based management strategy for Crystal Cave. It is the goal of this management plan to return "water to the [Cave] to provide a better environment for the amphipods and... [to] encourage a great financial return from the Cave through increased tourist visitation" (Hillman, 2000, p. 7). Tourist numbers should not only increase to the Cave in order to see the spectacular reflections, but also the endangered species and the project to save it.

1.2 SIGNIFICANCE OF THE STUDY

The purpose of this study is to evaluate the success of a current ecotourist based pilot project centred on Crystal Cave at Yanchep National Park. This project is aimed at keeping an endangered aquatic species alive until improved land management practices can artificially recharge of the natural water table. The development of a tourist management strategy aimed at environmental degradation by tourists, should benefit Crystal Cave by injecting funds from visitors into conservation works. Tourist revenue may have the potential to pay for a significant portion of the project without the aid of additional government grants. Therefore, if

Crystal Caves water system and newly discovered life form can be saved while increasing funds from tourist visitation, this would then provide an example of a successful ecotourist based management model.

1.3 PURPOSE OF THE STUDY

The purpose of this study is to show that if properly managed, ecotourism can not only be ecologically sustainable, but it can also increase the available funds for the management and conservation of an environmentally sensitive area. While ecotourist based management models are still a relatively new concept in the tourism industry, this study has the potential to provide a contemporary example of how ecotourism can benefit an ecologically threatened resource.

1.4 HYPOTHESIS

The working hypothesis for this research will be that properly managed ecotourist based developments can ensure ecological sustainability and raise funds for conservation from increased tourist exposure to an ecologically sensitive area.

A number of questions will need to be addressed

- 1. Is recharging the water levels within Crystal Cave and saving the amphipod species a financially and ecologically viable undertaking?**
- 2. Can this development be completed in an ecologically sustainable way?**

3. Can promotion of this project create enough public support to bring in needed financial resources?
4. Does the ecotourist gain an appreciation and understanding of the work being undertaken within the Cave, as well as an understanding of the human influences (plantations/extractions) on the local water table?

1.5 DEFINITION OF TERMS

1.5.1 ECOTOURISM

The accepted definition of ecotourism in this paper will be the EAA's interpretation, "ecologically sustainable tourism that fosters environmental and cultural understanding, appreciation and conservation" (CDOT, 1994, p. 3). This definition is comprised of five elements, four have been adapted by the Commonwealth Department of Tourism (CDOT), and one financial element adapted by myself. The financial element is justified as deserving special significance to a management strategy. Combined, ecotourism must have the following elements.

- a nature element
- an ecological and culturally sustainable element
- an educative and interpretive element
- an element based on provision of local and regional benefits; and
- a financially sustainable element

These elements will be further developed and explained in the chapter that further explains ecotourism.

1.5.2 ECOTOURIST

For the purpose of this study, an ecotourist is interpreted as anyone who has chosen to be involved in a nature-based tourist attraction that has an environmentally educative component and strives to be ecologically sustainable. It is important to note that ecotourists may not consider themselves as such. Nevertheless, as they have chosen such ecotourist based activities, they will be considered ecotourists. It is for this reason that all visitors to Crystal Cave are ecotourists, whether they have come to see the project, or come to experience the Cave environment.

1.5.3 SUSTAINABILITY

Using the *National Ecotourist Strategy's* definition, sustainability will be defined as management that avoids "or minimises negative impacts and [confers] benefits on host communities and environment, for present and future generations" (CDOT, 1994, p. 16). Within this definition there are two components that need to be further developed. Firstly, ecological sustainability ensures that no unnecessary and/or irreversible damage comes to any ecological element of the project. For example, ecological sustainability can only be considered successful if this project increases numbers of amphipods for future generations to enjoy, without damaging other parts of the Caves system. Secondly, financial sustainability will only be successful if appreciation for the project is able to create increased return visitors and word of mouth advertising to help fund ongoing work within the Cave.

1.5.4 NATURE-BASED TOURISM

Nature-based tourism is often confused with ecotourism. For this study, nature-based tourism includes any form of tourism that has the natural environment as a main attraction. Although this does include ecotourism, it also includes possible unsustainable tourism activities such as adventure tourism and camping.

1.6 THEORETICAL FRAMEWORK

Although there are a great number of theoretical concepts that could be used, two in particular will be considered most crucial.

1.6.1 SYSTEMS APPROACH

The first theoretical concept that will be considered vital to this study is that of *systems approach* as it is used in geography. Dealing with all parts of the environment, the main concern with this style of research is the “*connectivity within a system [being] its most important characteristic*” (Ackerman, 1972, p. 265). In this manner, the *systems approach* implies that every aspect of the environment and culture is connected. A negative impact on one part of a tourism development will inevitable have negative impacts in other parts of that same development and the broader environment. Like the concept of *ecosystems*, the *systems approach* involves a much greater emphasis on interrelationships binding human intellect and activity into the equation. It is in this manner that human knowledge and interest become one of the interconnected aspects of the environment, able to degrade or be degraded by it.

1.6.2 SUSTAINABILITY

The second key concept that is found often throughout this project is sustainability. Sustainability is a concept that has appeared in geographic literature for decades (United Nations World Commission of Economic Development (WCED), 1987; Ceballos-Lascurain, 1996; Mowforth & Munt, 1998; Honey, 1999), although it was the World Commission on Environmental Development (WCED) that brought sustainability to the forefront of geography by bringing the idea of sustainable development to prominence in 1987. According to the WCED, sustainable development is

development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

(WCED, 1987, p. 43)

The main concept within sustainable development is that of avoiding degradation of resources "(tangible or not) so that future generations can enjoy them. As this study is based on an ecotourist based management strategy, sustainability here deals with *management* that "[avoids] or minimises negative impacts and [confers] benefits to host communities an environments, for present and future generations" (CDOT, 1994, p. 16). Management of this ecotourist based model must not only ensure that the amphipods are protected for future generations (ecological sustainability), but also ensure that funds spent are substantially recovered through tourist dollars (financial sustainability), to ensure that CALM rangers can continue the work without great assistance.

1.7 LIMITATIONS

Limitations for this research included a time factor and a lack of information factor. The first of these limiting factors that needed to be approached was the question of time. As this study coincided with the Cave's pilot project, there was likely to be difficulties in obtaining information at the different points in time. Also, if the CALM rangers' pilot project had been delayed for a great deal of time, my study would have had to change its focus and analyse the projects progress, not completion. Unfortunately, delays are unavoidable and back up plans must be in place for drastic changes.

The second limitation also arose due to the concurrence of the thesis and the pilot project it is studying. However, lack of information is not a serious problem, as qualified people that can give 'educative estimates' were available throughout the project.

1.8 LITERATURE REVIEW

1.8.1 ECOTOURISM

The first section of this literature review explains the difficulties surrounding the definition of ecotourism. Given the variety of interpretations accepted today, it is important to establish a working definition of ecotourism to be used throughout this research

In recent years, increased environmental concern throughout society has resulted in greater public awareness about the effects of human actions on their surroundings. In the tourism industry, this has resulted in the concept of ecotourism. No significant mention of ecotourism existed before the 1980's, although it was often grouped with such concepts as adventure tourism or sustainable tourism. Hector Ceballos-Lascurain is given credit for formulating the first meaningful definition of ecotourism in 1980 (cited in Harrison & Husbands, 1996, p. 385). Ceballos-Lascurain's in-depth interpretation of ecotourism is widely accepted in large part because of Boo's reference to it in her widely published text, *Ecotourism: The Potentials and Pitfalls* (Boo, 1990).

Ecotourism, according to Ceballos-Lascurain and Boo is:

Tourism that consists in travelling to relatively undisturbed places or uncontaminated natural areas with the specific objective of studying, admiring, and enjoying the scenery and its wild plants and animals, as well as any existing cultural manifestation (both past and present) found in these areas.

(Ceballos-Lascurain, cited in Boo, 1990, p. 2)

With early definitions as encompassing and broadly based as Ceballos-Lascurain's, ecotourism often remained imprecise. However, two underlying principles within Ceballos-Lascurain's interpretation are

consistent with many other researchers' determinants of ecotourism. These principles include travel to a natural area, and an emphasis on respect to native culture (Boo, 1990; Honey 1999; Mowforth & Munt, 1998; Weaver, 1998). Throughout the 1980's, many versions of ecotourism were developed building on these two key principles. Their foundations were further clarified when the Ecotourism Society, a membership organisation based on the promotion of ecotourism, defined ecotourism in 1991 as: "Responsible travel to natural areas that conserves the environment and improves the well-being of the local people" (as cited in Honey, M., 1999, p. 6). Although the emphasis was still on travel to natural areas and improving the well being of local people, the original definition was condensed to make the term more applicable to a number of different scenarios.

As technology further developed into the 1990's, increased globalisation allowed trends in tourism to move more towards travel in the Third World (Boo, 1990; Ceballos-Lascurain, 1996; Mowforth & Munt, 1998; Weaver, 1998; Honey, 1999). Trends in ecotourism focused primarily on ecotourism developments involving visitors from the developed countries of the world travelling to the more untouched developing nations of the world (Boo, 1990; Ceballos-Lascurain, 1996; Mowforth & Munt, 1998; Weaver, 1998; Honey, 1999). Consequently, researchers involved in ecotourism also started to concentrate on the effects of tourism to local inhabitants of these new tourist destinations. Often included in this recent research of ecotourism are empowerment of the local people, and respect for the native culture (Honey, 1999; Weaver,

1998; Mowforth & Munt, 1998; Harrison & Husbands, 1996). Still concerned with ecological sustainability, work has increasingly focused on the social and cultural aspects of travel. A high proportion of work in the ecotourist field still addresses on this aspect of tourism on the Third World.

It is important to note that although there is much research into the social injustices of ecotourism throughout the world, ecotourism developments based mainly on ecological issue have also been well examined. Examples of these include the gorillas in Zimbabwe (Mowforth & Munt, 1998), Turtles in Costa Rica (Mowforth & Munt, 1998), and even Pacific Salmon in Canada's west (Ceballos-Lascurain, 1996).

Having entered into the twenty-first century, recent government initiatives regarding ecotourism have been developed in Australian tourism. Realising that tourism is one of the fastest growing industries, and that ecotourism is an important distinction of tourist and travel, governments in developed nations have established ecotourist based management strategies for their respective countries. Australia is no exception. Much of the research now done in the field of ecotourism is done by government bodies and groups incorporating business management and marketing strategies in an attempt to increase national tourist income (CDOT, 1994; Walmsley & Murray, 1998; Newson, 1999). One of the first major developments in this government based research direction was the *National Ecotourism Strategy*, developed by the CDOT in 1994 (CDOT, 1994). This document outlines a management strategy for ecotourism managers in Australia. As an official government strategy on

ecotourism, this paper attempts to provide for Australia a model for planning, developing and managing successful ecotourism.

As ecotourism continues to grow as an industry, government groups such as CALM, and the EAA sponsor conferences and encourage the development of strategies for the improvement of ecotourist based travel management within Australia (CDOT, 1994; CDOT 1995; Walmsley & Murray, 1998; Newson, 1999). Based more on development and management of ecotourist based strategies in the context of a developed country, conferences and strategies such as these are extremely important for an Australian based model.

The accepted definition of ecotourism in this paper will be the EAA's definition cited by the *National Ecotourism Strategy* as:

"Ecologically sustainable tourism that fosters environmental and cultural understanding, appreciation and conservation" (EAA as cited in CDOT, 1994, p. 3). As mentioned earlier, this definition comprises of five elements, a nature element, an element based on ecological and cultural sustainability, an educative and interpretive element, a provision to local and regional benefits element, and a financial element. Having successfully included these elements, two main areas of focus to analyse your ecotourism study are ecological sustainability and financial sustainability. Ecological sustainability requires that ecological elements are improved as a result of the tourist activity. The second requirement for ecotourism in a management strategy is financial sustainability. Financial sustainability has been adapted from the E.A.A's definition of ecotourism as the conservation of an element, payed for in part by increased tourist

dollars brought in by an ecotourist based management system aimed at visitor understanding and appreciation.

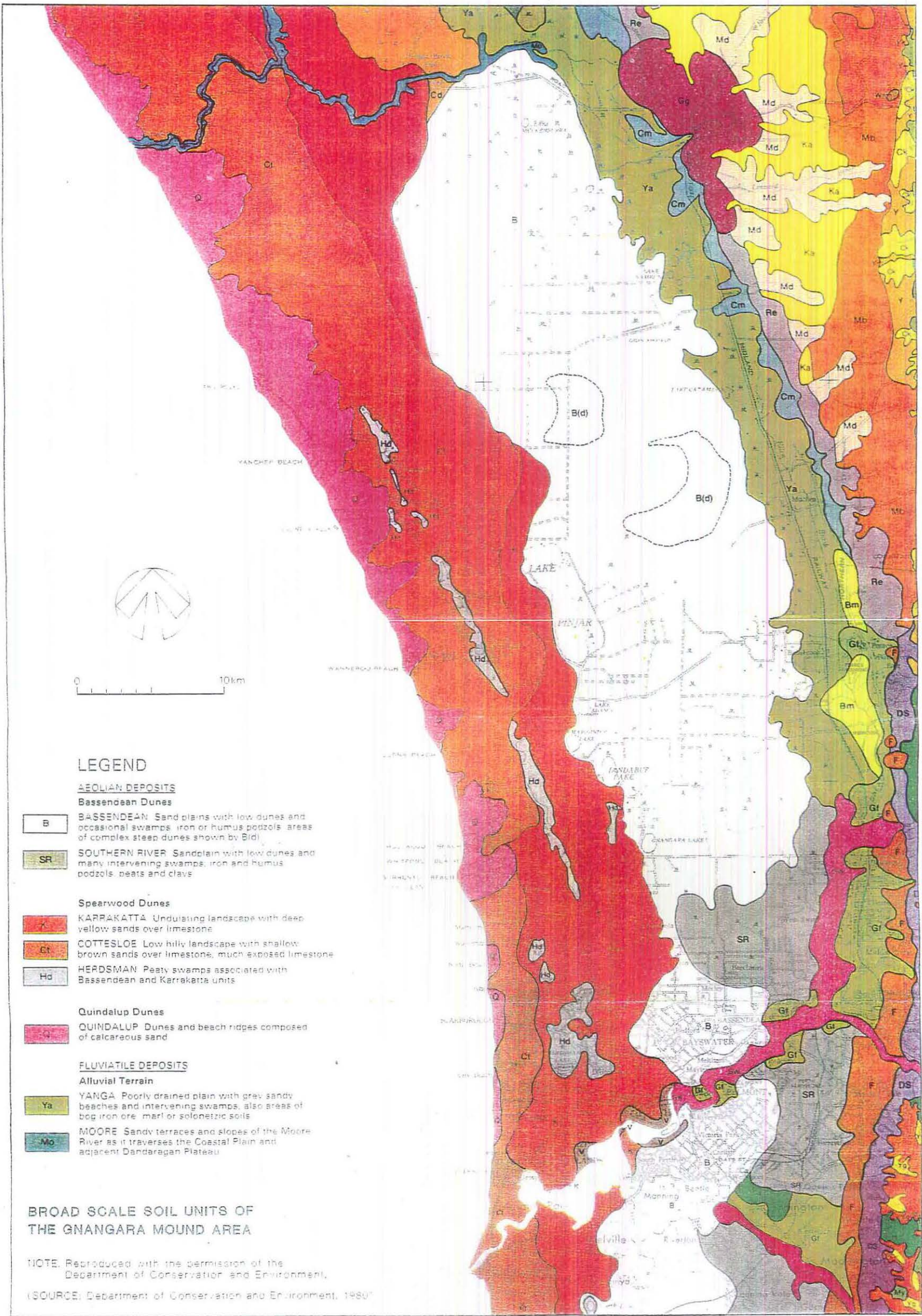
1.8.2 CRYSTAL CAVE AND THE SPECIES FOUND WITHIN THE CAVE

Further material to be addressed in this research is that relevant to Crystal Cave and the amphipod species found within it.

Caves found within Yanchep National Park, including Crystal Cave are primarily formed of Tamala limestone. Tamala limestone was created in Yanchep during the Pleistocene epoch when calcareous material (shell material from the sea) was stranded within the dune systems during times of global interglaciation. During the times of glacial recession, sea levels were at their highest, depositing calcareous material of the Spearwood dune system on top of the uncalcareous Bassendean sands (see Figure 2). This calcareous material was reciprocated down through the dunes by increased moisture. With the aid of acidic plant material also leached through the sands, calcareous matter was recemented as limestone, often in karst formation (Bastian, 1992; Jasinska, 1997).

Groundwater found within the Yanchep caves is accepted to originate from the Gnangara Mound (see Figure 3) (Webster, 1989; Bastian, 1992; Jasinska, 1997; Hillman, 2000), a large body of water occurring within the Bassendean sands. These sands form the oldest of the dune systems in the Swan Coastal Plain (Jasinska, 1997; Bastian, 1992) (see Figure 4). Most water resource issues within the Swan Coastal Plain are under the jurisdiction of the Western Australian Water Resources Council (WAWRC), the WRC and the Water Authority of Western Australia

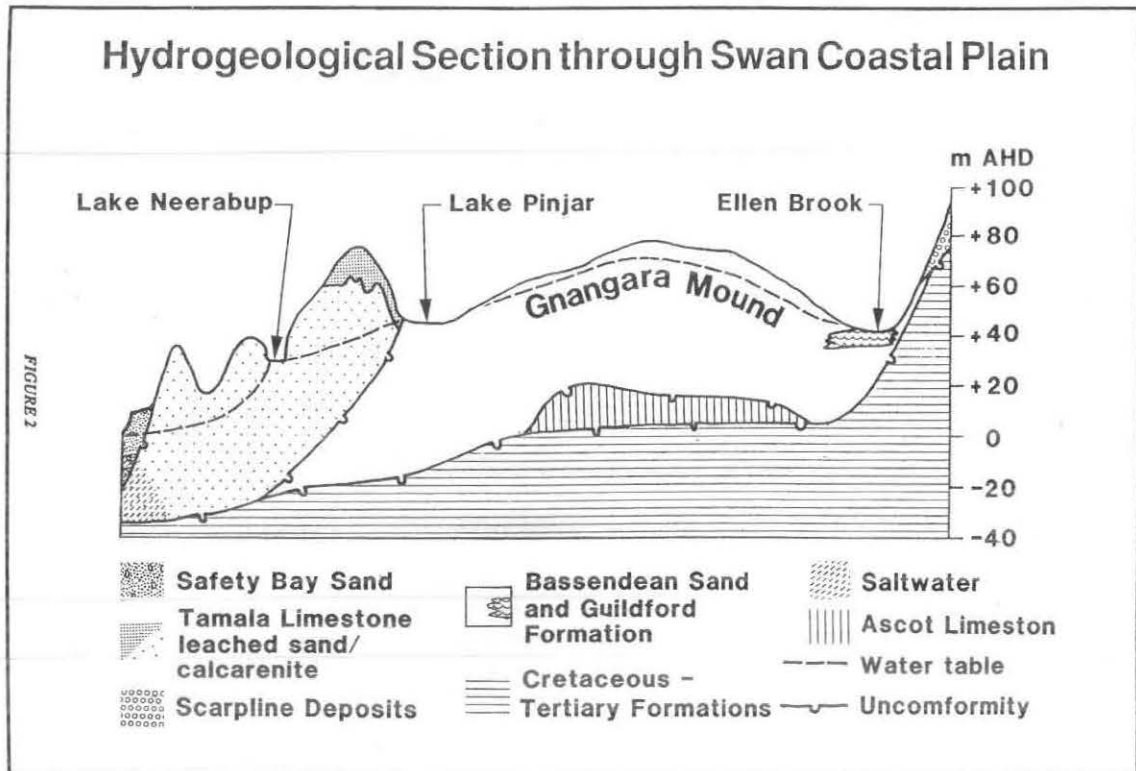
FIGURE 2



SOIL UNITS OF THE GNANGARA MOUND

Source: Water Authority of Western Australia. (1986).

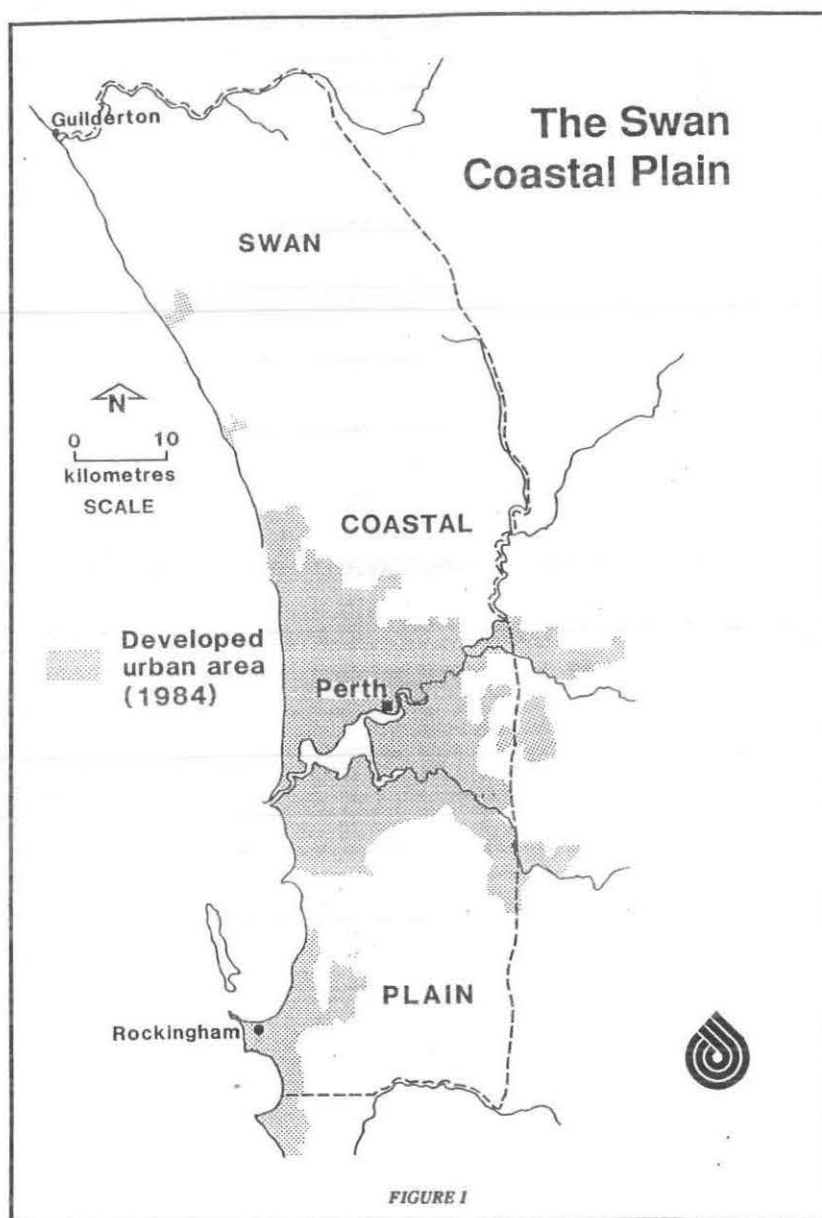
FIGURE 3



CROSS SECTION OF THE GNANGARA MOUND REGION

Source: Webster, K. (1989).

FIGURE 4



THE SWAN COASTAL PLAIN

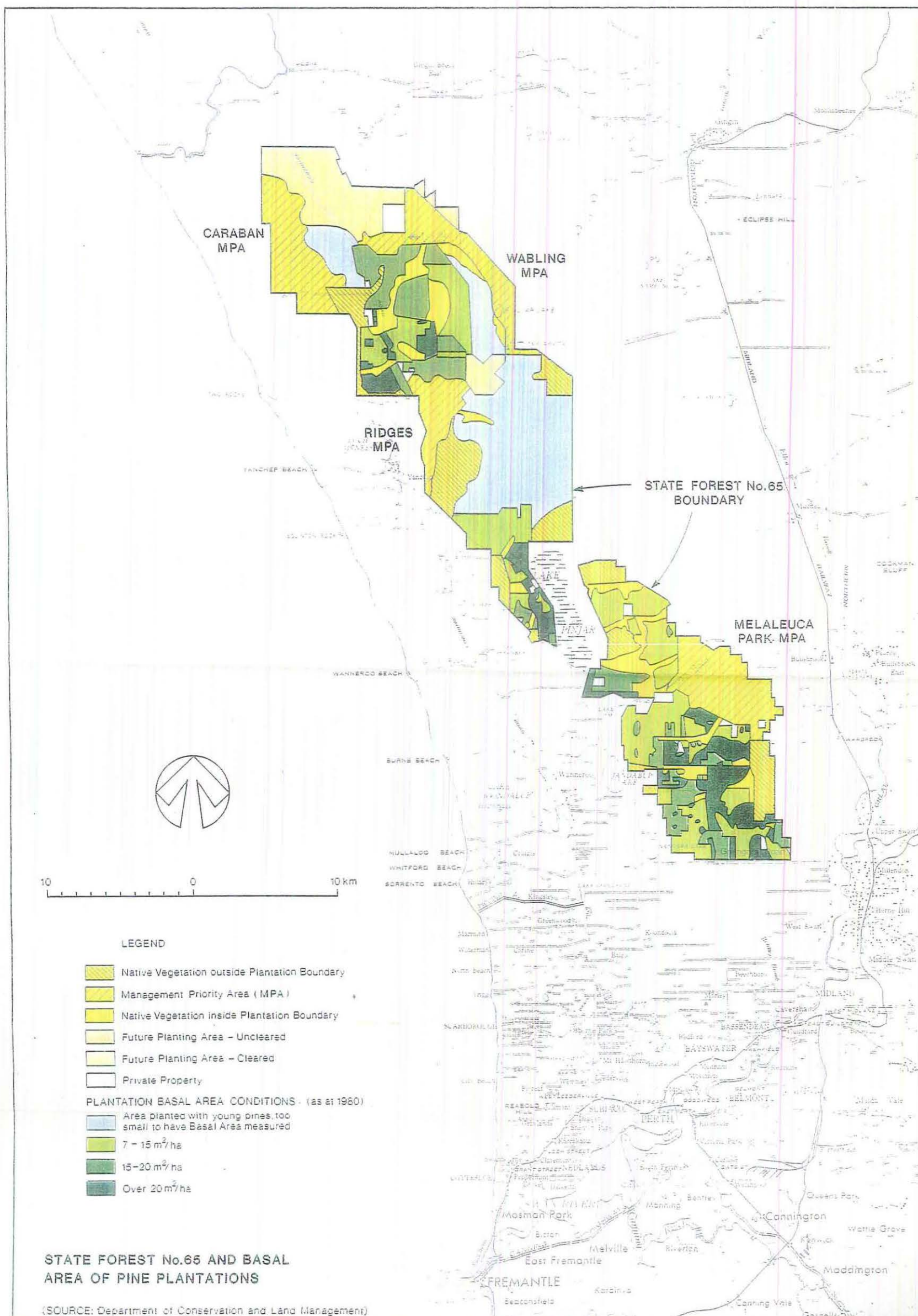
Source: Webster, K. (1989).

(WAWA). Because of this, most research regarding the Gnangara mound is in the form of government generated documents on the supply and demand of water for the Perth Metropolitan area, and the maintenance groundwater quality (WAWA, 1986; WAWRC, 1989; Godfrey, 1997; Pionke, Sharma & Hoskings, 1990).

In the 1990's, a new topic emerged with regards to the Gnangara Mound, focussing on decreasing water levels. Water levels within the Gnangara Mound began dropping dramatically causing underground pools within the Yanchep caves to dry up. Research has examined why this drop in water levels has occurred (Webster, 1989; Singleton, 1989; Bastian, 1992; Jasinska, 1997). Increased discharge groundwater by Perth's northern suburbs, planting of maritime pine plantations, *Pinus pinaster* (see Figure 5), and the drying of soils; combined with decreased recharge of the water table from a changing climate have been identified as the main reasons for dropping water levels within the Park (Singleton, 1989; Jasinska, 1997; Hillman, 2000; Anthony, 1999).

Decreasing water levels within the cave system has not only damaged flora and decreased the number of tourists to the Park (see Table 1), but also endangered a number of recently identified amphipod species (Jasinska 1997; Anthony, 1999; Hillman, 2000). Discovered in 1982 by Dr. Brenton Knott (as reported by Hillman, 2000), these unique subterranean crustaceans have been detected residing in the Cave groundwater of Yanchep National Park. Building on Dr. Knott's research,

FIGURE 5



STATE FOREST NO. 65, AND BASAL AREA OF PINE PLANTATIONS

Source: Water Authority of Western Australia. (1986).

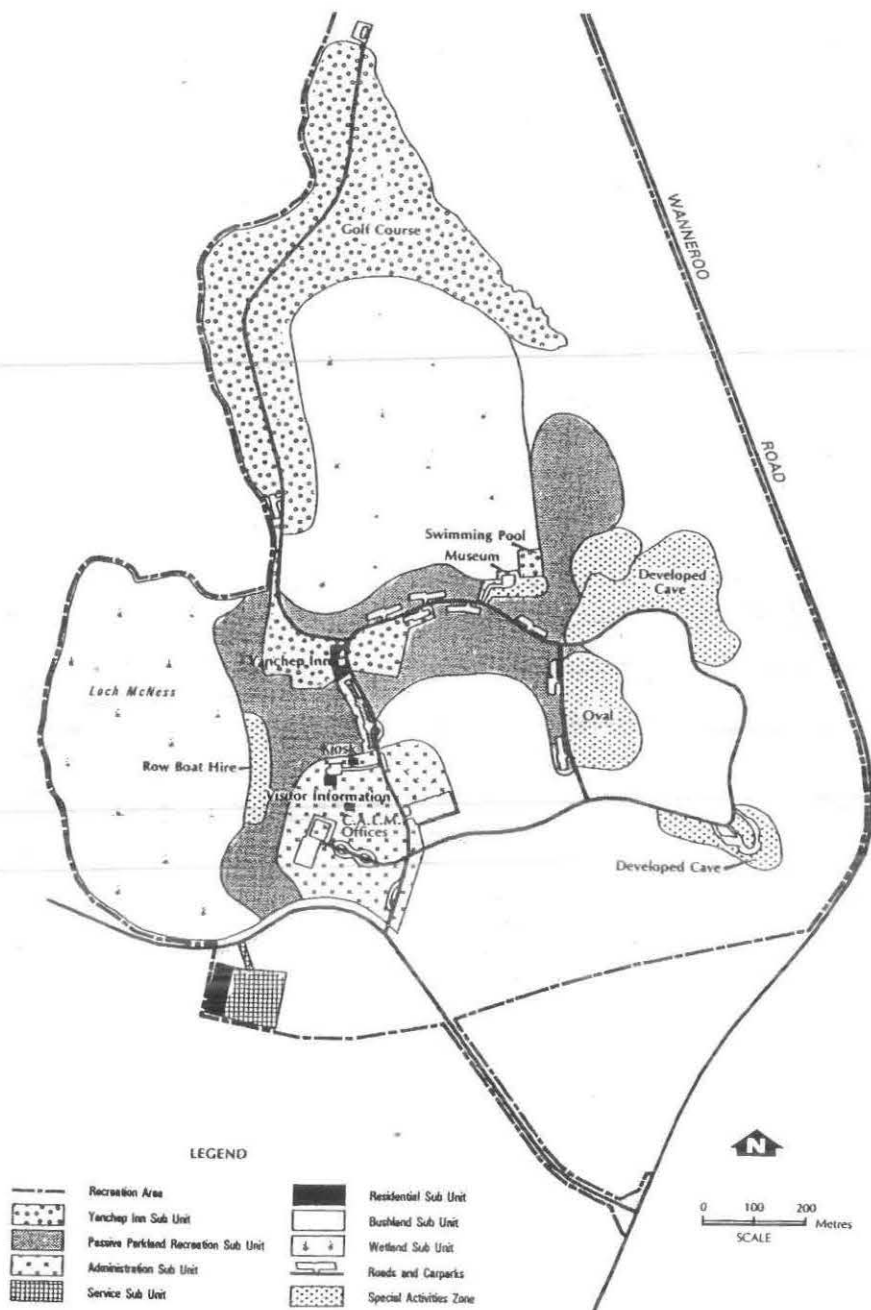
Dr. Edyta Jasinska has since found a further species in the genus *Hurleya* that resides only in the permanent groundwater of Crystal Cave (Anthony, 1999; Hillman, 2000). Feeding on the algae found within the Cave, and unable to migrate from the Cave, this new species will face certain extinction as the groundwater within Crystal Cave retreats below the Cave floor (Anthony, 1999; Hillman, 2000). Since these creatures were "first discovered and collected in February 1996," (Anthony, 1999, p. 1) very little information and research has been gathered on this new, and still unclassified species.

Headed by Rod Hillman (Park Manager), Paul Tholen (CALM ranger) and the other CALM rangers within Yanchep National Park, current research is now being carried out in an attempt to rejuvenate groundwater and restock amphipod species within Crystal Cave. Using an ecotourist based management strategy, Rod Hillman and the CALM rangers are also attempting to fund this project through increased tourist income brought in by the rejuvenation of Crystal Caves water system. It is this current research within Crystal Cave that will provide the base information for the research involved in this paper.

2.1 SITE LOCATION

This study was conducted on Crystal Cave (see Plate 1) in Yanchep National Park, Western Australia (see Figure 1). Located only 50 kilometres north of Perth, Yanchep National Park is a popular weekend destination for city residents. With such a high visitor base, the Park has developed many features to facilitate and attract tourists. Such features include various walking trails, boats on Loch Mcness, a kangaroo and emu enclosure, a lodge and a golfcourse (see Figure 6). In addition, numerous social events are sponsored to encourage a wide range of participants. Particular importance in Yanchep are the limestone caves that exist within the Park boundaries. With natural flowing springs and spectacular stalactite and stalagmite features, these caves are a major tourist attraction throughout the year. In terms of tourist numbers, the most successful of these caves is Crystal Cave, which experiences the highest visitation of any cave in the State (CALM, 1989, p. 151). In addition, Crystal Cave is the location of the amphipod species, as well as the site of the ecotourist based management pilot project. All research for this study will be carried out within a large section of Crystal Cave called the Pantheon (see Figure 7).

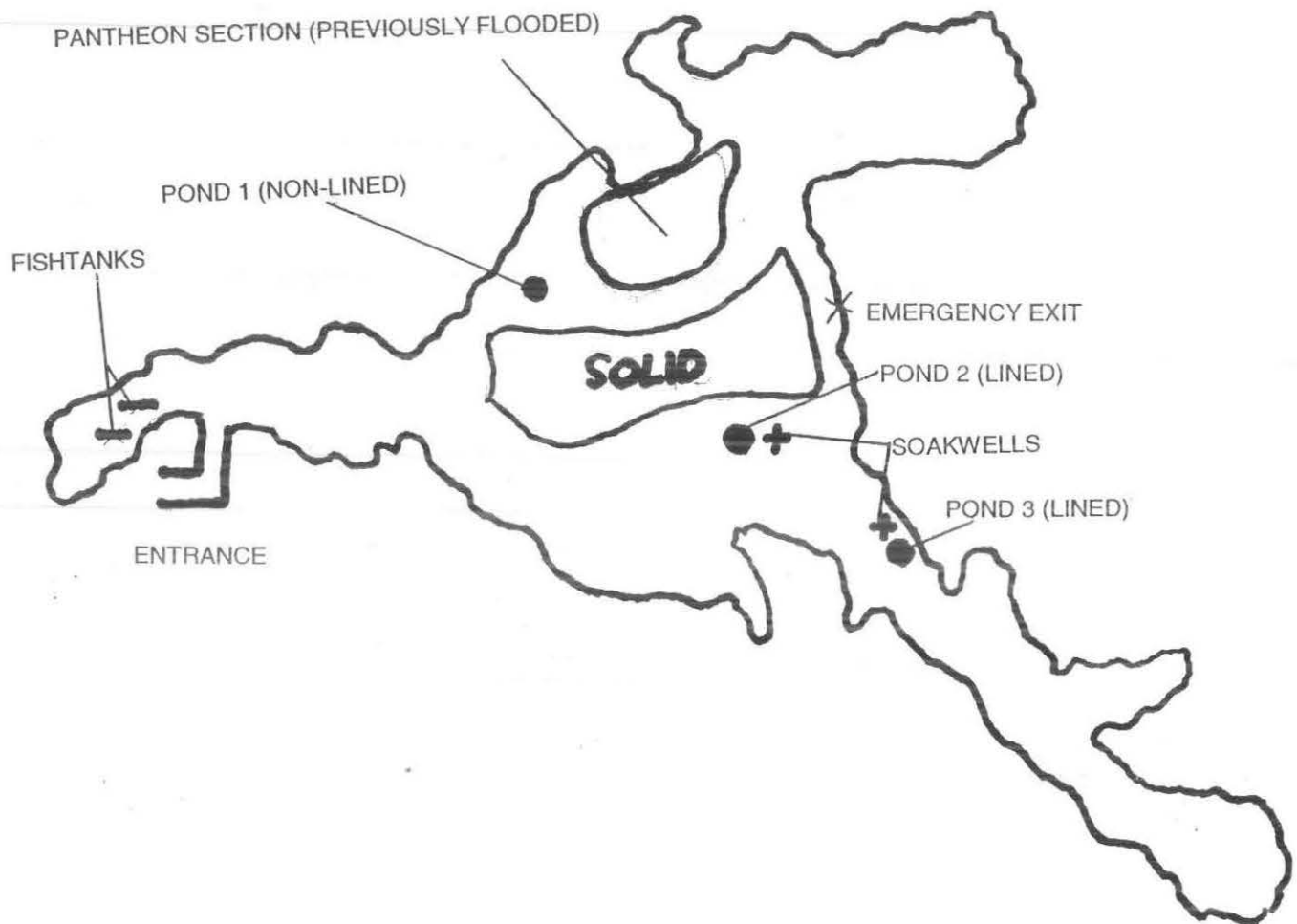
FIGURE 6



FACILITIES LOCATED INSIDE YANCHEP NATIONAL PARK

Source: Department of Conservation and Land Management. (Ed.). (1989).

FIGURE 7



DIAGRAMMATIC SKETCH OF CRYSTAL CAVE

Source: Traced from sketch provided by Paul Tholen, ranger in charge of Cave project

2.2 DESIGN

Two studies were undertaken in order to evaluate the success of the Crystal Cave ecotourist based management project. These studies included a questionnaire study aimed at evaluating visitors appreciation of the project, along with an ongoing evaluation of the pilot project occurring within Crystal Cave.

2.3 QUESTIONNAIRE STUDY

In order to project future sustainability of Crystal Cave, the first study was conducted to analyse tourists' feelings towards the project. In order to determine tourists views, a questionnaire had been developed (see Appendix 1). A questionnaire was the best means in which to contact a large number of respondents permitting a more accurate cross section of cave visitors to be represented in the study.

2.3.1 QUESTIONNAIRE BREAKDOWN

The questionnaire used in this project is presented in four separate sections. These sections allow further breakdown and analysis of responses later in the study. Much work has been put into making each section of the questionnaire as brief and to the point, as "lengthy questionnaires discourage responding... and usually reflect a lack of clarity" (Deschamp & Tognolini, 1983, p. 2).

General questions on the background of respondents comprise Section A, and are included to identify the origin of visitors, their age, and general motivations for visiting the Park and/or Cave. This section is used

mainly in the determination of who is visiting the Park, and what has encouraged them to participate in the Crystal Cave tour. This information permits an analysis of the demographics of the participants to such an ecotourist based activity. Also, by starting the questionnaire with simple, non-contentious questions, participants are eased into participation, increasing respondent numbers.

Section B of the questionnaire attempts to reveal visitors' general feelings about the Crystal Cave tour. Included are inquiries regarding the willingness of visitors to return to Crystal Cave (if in Perth area), as well as their opinion on recommending the tour to others. This section will identify the participants appreciation of the tour in general.

A third section deals with financial aspects of the Crystal Cave tour. Taking section B one step further, this financial section requests respondents to comment on the value of their visit. Having recently almost doubled tour prices in order to pay for the current project, answers found here will be used to determine if visitors find the new price acceptable. However, the intent is to examine attitudes to the current price and in so doing does not mention the previous price. Hence, comparable price analysis is avoided.

Finally, section D focuses on feelings about the validity of the project itself. Questions involved in this section determine whether visitors have gained an understanding and appreciation of project throughout the tour. Given positive responses it can be projected that ecotourism is a successful management strategy in this undertaking and it could be predicted that increased tourist income would continue in the future.

To achieve a high return rate on questionnaire responses, a face sheet has also been added that is brief, eyecatching and objective. The cover sheet makes "absolutely clear the purpose of the questionnaire" (Deschamp & Tognolini, 1983, p. 2) and communicates the intent of the research. Informed consent is obtained from respondents through their reading of the cover sheet. Participation is voluntary and anonymity is guaranteed. Also included are contact details if further information regarding the project is wanted.

2.3.2 SAMPLE

An ideal sample for this project would include every individual from the target population of participants to the Crystal Cave tour. Unfortunately, due to financial and time restraints, questionnaires were handed out on only two occasions. Working closely with the Park Manager, optimum times for high numbers of visitors were selected in order to maximise sample size. Making available the questionnaire to "each person in the total group involved" (Deschamp & Tognolini, 1983, p. 25), a simple random sampling method has been used. Participants in the survey may include any visitor to Crystal Cave not involved in the Cave project. Visitors with a direct relationship to Yanchep or the Crystal Cave project are excluded due to possible biases.

2.3.3 DATA ANALYSIS

All information gained from questionnaires will be represented in computer generated percentage based tables. These percentage based tables will be used to develop the significance of respondents' answers to the questionnaire.

2.4 CONCURRENT ECOLOGICAL AND FINANCIAL STUDY

The second part of this study will examine the concurrent evaluation taking place within Crystal Cave. This evaluation addresses both ecological and financial issues. The purpose of this study is to review these findings and within the context of these data to determine the potential to successfully sustain the Crystal Cave operations.

2.4.1 ECOLOGICAL SUSTAINABILITY

Ecological sustainability will be measured through

- a) an evaluation of the CALM rangers' ability to increase the amphipod species numbers,
and
- b) their ability to increase groundwater levels within this section of the Cave, while not damaging other elements of the Caves ecosystem.

Measurements of species numbers and groundwater levels will be obtained from CALM rangers' records as well as frequent personal observations.

Species numbers will be recorded throughout the project, starting in the mid 1990's with the earliest stages of the amphipod project when "only

about 15 [amphipods] were rescued by Dr. Edyta Jasinska and the Yanchep National Park rangers" (Hillman, 2000, p. 7), and only 80 in total estimated within the Cave. It is important to note here that due to the size and locations of the amphipod, exact numbers are not always available. In these circumstances, best estimations from either Dr. Edyta Jasinska (who was involved in the project from its onset), or CALM rangers (especially Paul Tholen whom is currently in charge of the Cave project), are regarded as the most accurate account. Measuring the raising of groundwater levels within this section of the Cave will include an outline of the equipment and process used to raise water levels. Success will be determined by the ability to maintain increased water levels once this section of the Cave is initially flooded. If the pilot project is not completed, success will be determined on the progress of that project.

Final analysis of ecological data will be presented in a report of CALM ranger ability to increase and maintain species numbers, as well as progress made with regards to groundwater levels within the Pantheon. Only when positive progress towards higher water levels are made will this project be considered ecologically sustainable.

2.4.2 FINANCIAL SUSTAINABILITY

This study will also examine the financial sustainability of the Crystal Cave project. A simple income-cost analysis will be used to compare expenditures endured in order to complete the project against financial return from tourist income via the Crystal Cave tour. The key to this section is the question of whether or not the increase in price to the

Cave tour is enough to pay for a substantial amount of the material used throughout the project. Effects of the possible change in tourist numbers due to the change in entrance fees must also be considered in this section. Responses gained from the questionnaire will permit an examination of both the cost secured and the changing nature of dropping water levels on tourist response and participation.

Resources for this section will come primarily from the Park Manager Rod Hillman, and will include an income statement for the pilot project, as well as official visitation and income records. Final analysis of financial data will be presented in a quantitative form.

2.5 SUMMARY

Two target populations, the ecotourists participating in the Cave tour, as well as the amphipod species found within the Caves' groundwater will measure sustainability of the ecotourist based model.

For the ecotourist population, assessment of a visitor questionnaire will be aimed at surveying guests' feelings about the project on an environmental level, as well as noting whether they are willing to either return or recommend the tour to others. Visitors who do not gain an appreciation of the project throughout the tour, or find that they have paid too much for what was offered, will be considered to have not had a positive reaction. This in turn will be considered as making the project unsustainable, as tourist numbers are likely not to increase. If this occurs, money needed to continue the project would not be available without additional government grants.

The second target population, analysed to measure ecological sustainability is the amphipod population resident in Crystal Cave. In order for this study to be considered ecologically sustainable, numbers of amphipods must increase and progress should be made in restoring the amphipods habitat in the Pantheon. Achievement of this will need to be completed in part by funds earned from continuous tourist visitation. Judgment of the amphipods' success will be developed with the evaluations of the scientific project being undertaken by CALM rangers within Crystal Cave.

CHAPTER 3: THE PARK ENVIRONMENT

3.1 INTRODUCTION

In order to better understand the management decisions taken within Australian national parks, this chapter will examine a detailed history of Australian national parks, paying particular attention to the history of Western Australia's national parks including Yanchep. This chapter will further clarify the socioeconomic context in which Australian national parks were developed during those early years. This in turn will provide a better understanding of the reasons park rangers initiated the ecotourism based management strategy in question today.

3.2 DEFINITION

The accepted definition of a national park in Australia, developed in 1970, is...

A relatively large area set aside for its features of predominantly unspoiled natural landscape, flora and fauna, permanently dedicated for public enjoyment, education and inspiration and protected from all interference other than essential management practices, so that its natural attributes are reserved.

(Jenkins, 1980, p. 1)

Within this definition there are a number of necessary elements:

1. a relatively large setting
2. set aside for natural features of predominantly unspoiled landscape, flora and fauna
3. permanently dedicated for public enjoyment, education and inspiration
4. protected from all other interference other than essential management practices

While the first two elements are often taken for granted by many people, it is the stated "dedication for public enjoyment, education, and inspiration", and "the protection from all interference other than essential management practices" that are often misunderstood and debated. It is for this reason that the definition of national parks solicits further examination. To understand the inclusion of such criteria in the definition, it is necessary to review the brief yet dynamic history of Australian national parks.

3.3 EARLY DEVELOPMENT OF AUSTRALIAN NATIONAL PARKS

Although natural and wild areas have been recognised, and respected, it was not until the American conservation movement in the late nineteenth century that the idea of national parks for public recreation and enjoyment was developed.

In the 1800's city gardens and protected areas were identified existing throughout the world. However, it was not until 1872 that the term 'national park' was first used. This came with the establishment of Yellowstone National Park in the United States (Brockmann & Marrian, 1979, p. 43). Created under the urging of President Grant, Yellowstone National Park was established as a land protected from development and grazing, for "the benefit and enjoyment of the people" (Strom, 1979, p. 46). Even in these early stages of development, national parks gained legitimacy as publicly accessible places, used for recreational activities in a natural environment. From these early beginnings, the development of

parks as public places dedicated for public enjoyment, education and inspiration, established the conditions that continue to exist.

It wasn't long after the creation of Yellowstone National Park that Australia inherited the idea of providing undeveloped areas for public enjoyment. Royal National Park, believed to be the second national park in the world, opened just twenty two kilometre south of Port Hacking in 1877 (Strom, 1979, p. 46).

The first significant groups of visitors to Australia's national parks, and the main supporters responsible for the parks initial growth, were naturalist and hiking clubs from the upper and middle classes. Looking to escape the hectic urban lifestyle, these groups would travel to the parks on the weekend in search of a relaxing and natural setting. With national parks originally formed more for social than environmental reasons, it wasn't long before a strong conservation movement was born out of these congregations. As these naturalist and conservationist groups grew, so too did their environmental influence, eventually ensuring that "the concepts of ecology and habitat protection became [more appreciated] and better understood" (Jenkins, 1980, p. 3).

The selection and location of these early national parks, in both Australia and America, initially appeared to have been created more for monumentalism than environmentalism (McEwan & McEwan, 1982, p. 3). Placed in areas unsuitable for development, early parks were located where land was considered to have low monetary value. Ironically, had it not been for these first governmental initiatives in national parks, early conservation movements of the late nineteenth century in such areas may

not have had such early beginnings. In turn, many positive environmental management practices established in the numerous national parks developed in these early stages set the conditions which provide the foundations for management strategies within the Australian park system of today.

Despite these strong beginnings, extensive growth in parkland did not occur until the Depression of the 1930's. During the Depression, Australian communities were

forced into dole lines, relief work and compulsory reduced incomes, and with few motor vehicles on limited and bad roadways, hiking and bushwalking became a very positive pastime.

(Strom, 1979, p. 66)

The Depression brought great numbers of Australians, from all classes to national parks. With all socioeconomic levels of Australian society now participating in bushwalking and other 'free' natural activities, the demand for increased numbers of national parks grew. A strong national conservation movement accompanied this. With the creation of more national parks, and a continued strong conservation movement, it wasn't long before the development of a National Parks and Wildlife Service was being discussed.

After the Depression, the people in New South Wales began discussing the creation of a National Park Service. Despite these early discussions, it was not until 1967 that the first National Parks and Wildlife Service was formally established. Formed with only forty members, the idea for such a body "had been the subject of discussion for decades" (Goldstein, 1979, p. 94). Shortly thereafter, all the States established

National Parks and Wildlife Services and a formal definition of a national park (as afore mentioned) was agreed upon. Combining not only ideas of a predominantly natural landscape one might expect in any park environment, the accepted definition also included the dedication to public enjoyment, education and inspiration that had been developed from the dramatic past one hundred years of national park history.

3.4 DEVELOPMENT OF NATIONAL PARKS IN WESTERN AUSTRALIA

With much of the history of national parks occurring in the eastern states, it is appropriate to look at the circumstances that helped develop the national park system in Western Australia.

3.4.1 EARLY DEVELOPMENT

With vast open lands, Western Australia has had a long history in providing natural areas for people's enjoyment. As early as 1831, forty years before Royal National Park's creation, Captain Stirling (Governor and Commander in Chief of Western Australia) was instructed to secure "places to be set apart for recreation and amusement of the inhabitants of any town or village or for promoting health of the inhabitants" (Jenkins, 1980, p. 19) in Western Australia. Common throughout Australia, we again see that the early development of park land was strongly based on public recreation and amusement. However, also common to other Australian States, Western Australia did not have reserved lands of great size until 1872, or an official National Parks and Wildlife Service until late in the twentieth century. Although Western Australia's early national park

history basically mirrors that of the rest of Australia, a brief history of the Western Australian National Parks and Wildlife Service (WANPWS) will provide a better understanding of the management of a Western Australian national park.

3.5 WESTERN AUSTRALIA'S NATIONAL PARK AND WILDLIFE SERVICE

Formed in 1975, the WANPWS was established under the Department of Environment and Conservation following recommendations made by the Australian Academy of Science in 1968 (Goldstien, 1979, 95).

The WANPWS has been the result of a progression of political boards. Born out of the Parks and Reserves Act of 1895, the first official Board in charge of managing natural areas in Western Australia was the State Gardens Board of 1920. The State Gardens Board was created by a request made from a Mr. L. E. Shapcott, who was, for the first week its only member. Mr. Shapcott went on to play a vital role in the history of Western Australia's national parks. In fact, it is widely believed today that had it not been for Mr. Shapcott's "continued interest, ingenuity and resourcefulness, Western Australia would probably be much poorer in parks with amenities for tourists" (Anon., 1968, p. 32). Controlling mainly urban parks and gardens, it wasn't until 1956 that greater management of natural areas was needed. With this, the State Gardens Board took on a much larger role and became the National Parks Board. It was this National Parks Board that eventually went on to become the WANPWS in 1975. The very next year, in 1976, national parks in Western Australia achieved strong political legitimacy with the passing of the National Parks

Authority Act. This Act put national parks under the responsibility of the minister of conservation and the environment (Goldstien, 1979, p. 109). It was this Act that also

brought to an end almost 20 years of uncertainty and improvisation for the National Parks Service and gave a clear indication of its changed states and the rapid growth expected in the future.

(Jenkins, 1979, p. 21)

While there were many developments regarding the management and control practices of national parks, those pertaining to Yanchep National Park will only be included in this discussion. All national parks in Western Australia, including Yanchep National Park, are now vested in the National Parks and Nature Conservation Authority (NPNCA). The NPNCA is responsible for the creation of park management plans. Management of these parks is carried out by CALM (Allin, 1990, p. 41).

3.6 A HISTORY OF YANCHEP NATIONAL PARK

One of the earliest developed and most used parks within this history, and the Park in which this research takes place, is Yanchep National Park (see Figure 1). Located only 50 kilometres north of the city of Perth, and with a variety of natural features, Yanchep National Park became one of the first developed and most used parks in Western Australia.

Yanchep National Park derived its name from the aboriginal word Yanget, applied to the bulrush, *Typha orientalis*, which is abundant throughout the wetland areas of the park. Wetland uses in the Yanchep area have a long aboriginal history. Used for centuries by the Nyoongar

aboriginal people as a rich source of food during the driest season, Bunuru, the first recorded European visitor wasn't until 1834. Simply searching for lost cattle 53 kilometres north of Perth, Jack Butler was the first to record lakes and an abundance of game.

European settlement to the area didn't occurred until almost 70 years after Mr. Butler visited, when a Mr. H. White took "up grazing land and erected a house" (Jenkins, 1979, 39), on what is now Loch McNess. Mr. White became the first European to settle in the Yanchep National Park area. Shortly after initial European settlement, many natural limestone caves were discovered in the area. Caves in the Yanchep area were formed during the Pleistocene epoch, when calcareous material was deposited and stranded within the Bassendean sands (see Figure 2), later to be reciprocated down to form limestone karst formations (Bastian, 1992; Jasinska, 1997). With spectacular sites and an extreme natural beauty, the Western Australian government was quick to designate the area in 1905, as a Class A reserve. This reserve was designated for "the protection of caves and flora and fauna and for health and pleasure resort" (Jenkins, 1979, 39). Again we see the not only early environmental protection aspects, but also the idea of health and pleasure of residents found throughout the history of Australia's national parks.

Although creation of the reserve transpired early, it wasn't until the depression years that much structural development occurred. During the depression however, a philanthropist named Sir Charles McNess, made generous donations to the State Gardens Board (with the afore mentioned Mr. Shapcott as Chairman). These donated funds were used to organise

programs aimed at getting out of work people employed in the construction of tourist developments in the areas now occupied by Yanchep and John Forrest National Parks (Anon., 1968, p. 32). In the Yanchep area, this construction created many roads, and the building of residential facilities that included McNess Guest House, Yanchep Inn, and the Gloucester Lodge. Tourist facilities in Yanchep dramatically increased after this early construction, eventually including boating facilities, a wildlife enclosure, as hostel (now museum), as well as a nine-hole golfcourse (see Figure 6).

Located so close to Perth, the largest city in Western Australia, Yanchep National Park became a popular tourist destination from its early beginnings. With early tourist facility developments occurring in the 1930's, Yanchep National Park now enjoys "the highest number of visitors to any single area of a national park in the State" (CDOT, 1989, p. 151). In order to do a research study on tourism to these caves, one must first understand the strong historical significance tourism has had to these caves.

3.7 YANCHEP CAVES

The primary resource responsible for Yanchep's designation as a Class A Reserve, and later National Park, was the discovery of the limestone caves that are found throughout the Park. With over 1000 caves now recognised in Yanchep, the first European discovery of them was not until 1838, by Lt. (later Sir) George Grey. Further discovery of many other caves in South Western Australia within the next fifty years encouraged the formation in 1902 of a Caves Board set up for the

protection of these natural resources. Originally in charge of the caves in the area of what is now the Leeuwin Naturaliste National Park, the Caves Board acquired control of the Yanchep caves in 1905 (Anon., 1968, p. 25). Within eight years the Caves Board successfully opened caves in the Margaret River, Yallingup and Yanchep areas as tourist resorts (Anon., 1968, p. 30), before being dissolved in 1910.

With such an early beginning as a tourist resort, caves in Yanchep National Park have been frequent visitor attractions for almost 100 years. Perhaps one of the largest and most fascinating caves in the Park, and the site of this study, is Crystal Cave.

3.8 CRYSTAL CAVE

Arguably the most spectacular cave found in the Yanchep area is Crystal Cave (see Plate 1.0). Originally called Crystal White Cave in 1903 by its discoverer Mr. H. White (original settler to the area), the Cave was named after the spectacular reflections of the rock formations emanating off a groundwater stream. Open to tourism since 1903, Crystal Cave quickly became an important tourist attraction in the Perth area (Hillman, 2000, p. 7). With the edition of electric lights by dole workers in the 1930's, and continued development ever since, Crystal Cave now enjoys the highest visitation of any cave in the State (CALM, 1989).

It should be noted that although Mr. White is credited with the discovery of Crystal Cave, aboriginal people of the area did have knowledge of it. However, being one of the deeper caves, aboriginal people never entered Crystal Cave willingly. Having now form of light

other than fire, aboriginals feared the Caves unknown darkness and a spirit called the Jinka.

Unfortunately, due to recent climate conditions and improper environmental management practices in the region, the last decade has been marred by the dramatic decrease of groundwater within the Cave that threatens to dry up completely. This decrease in groundwater has not only caused the loss of aesthetic qualities for which Crystal Cave is famous, but it has recently been discovered that this groundwater is the only habitat found in the world for a new, and not yet classified species of amphipod.

It has now become the management strategy of Yanchep National Park's CALM rangers, along with the WRC to develop a management strategy that will artificially maintain groundwater levels until such time that the necessary water is returned to Crystal Cave naturally. Requiring management practices suitable for the twenty first century, a relatively new method of management has been adapted; ecotourism. Ecotourism has the potential to not only recharge the groundwater within Crystal Cave, therefore saving the new species, but could also maintain tourist involvement in an educational and enjoyable manner which has been the promise of national park management in Australia from its earliest beginnings.

3.9 SUMMARY

Originally developed for the enjoyment and education of the public, national parks throughout Australia have had a dynamic history. One of the earliest parks to be developed in Western Australia was Yanchep National Park. Originally made a Class A reserve for its fantastic caves and flora and fauna, the Park has enjoyed great development and tourism over the last 95 years.

Recently however, one of the spectacular and most visited caves in the Park, Crystal Cave, has come under increased ecological pressure with the lowering of the groundwater levels within the Cave. Destroying not only the aesthetic value of the Cave, lowering of the groundwater is threatening the habitat of a newly discovered, and as yet unclassified species of amphipod. It has now become the focus of CALM rangers, as well as the WRC to save this species by adapting an ecotourist based management strategy suitable for the Caves environment.

The decision to use ecotourism in Crystal Cave is born from Australia's dynamic social, ecological, and economic history. Attempting to combine parks early tourist beginnings, and an ecological definition of national parks aimed at protection "from all interference other than essential management practices" (Jenkins, 1989, 1), parties involved have recognised ecotourism as their most promising management strategy.

CHAPTER 4: ECOTOURISM AND DEVELOPMENT

4.1 DEFINITION OF ECOTOURISM

In response to a management strategy that would satisfy both ecological and social issues for Crystal Cave, CALM rangers, along with the WRC have adapted strategies based on an ecotourism model. While an often misunderstood and poorly interpreted term, this chapter sets out to define ecotourism, and demonstrate why it has been selected as an appropriate management strategy for Crystal Cave.

The history of ecotourism can be said to have truly started in 1980, when a man by the name of Hector Ceballos-Lascurian coined the expression ecotourism as

tourism that consists in travelling to relatively undisturbed places or uncontaminated natural areas with the specific objective of studying, admiring, and enjoying the scenery and its wild plants and animals, as well as any existing cultural manifestation (both past and present) found in these areas.

(Ceballos-Lascurian, cited in Boo, 1990, p. 2)

When first defined by H. Ceballos-Lascurian, this broad based term did not gain immediate political recognition.

Published in 1980, the International Union for Conservation of Nature and Natural Resources (IUCN), *World Conservation Strategy*, brought the expression 'sustainable development' to the forefront of political agenda's. Sustainable development gained instantaneous recognition as a powerful environmental catch phrase, and was soon adapted by the United Nations WCED (WCED, 1987). Chaired by the Prime minister of Norway, Gro Harlem Bruntland, the goal of this

Commission was to develop a global agenda for change that was based on the ideals of sustainable development (WCED, 1987). The WCED published their findings in 1987 in a book entitled *Our Common Future*. In doing this, the WCED became the largest and most influential group to emphasize that “development needed the prefix sustainability” (Holdgate, 1996, p. 43). *Our Common Future* defined sustainable development as

development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

(WCED, 1987, p 43)

The main idea of sustainable development in this definition is that development today, no matter what the field, does not compromise developments of the same nature in the future. In this manner development can sustain itself, fulfilling the objective of sustainable development.

It is no surprise that the term sustainable development impacted upon the tourist industry. This led to the notion of ecotourism. Ecotourism was soon popularised as the use of sustainable development in the tourism industry.

By the start of the 1990's, ecotourist based political groups such as the Ecotourism Society, a membership organisation based on the promotion of ecotourism emerged around the globe. These new groups, each with their own agenda and ideals, refined definitions of ecotourism to suit their own particular needs; the Ecotourism Society in 1991 for example, defined ecotourism as “responsible travel to natural areas that conserves the environment and improves the well being of the local

people" (as cited in Honey, 1999, p. 8). The problem with many of these definitions was that they were created for a particular situation, often irrelevant in other situations.

Sensing this complexity, national governments began introducing their own ecotourist based groups and developing their own definitions. Australia was no exception. Australia formed the EAA in 1991, and CDOT developed the *National Ecotourism Strategy* in 1994 (CDOT, 1994). The *National Ecotourism Strategy* was created by the national government as an official government agenda, based on the development of sustainable models of planning in the Australian tourism industry. This model is fundamental to this research.

Having demonstrated how quickly the ecotourism industry is growing in Australia, and the difficulty of numerous definitions, it is vital to find a definition of ecotourism applicable to the present study.

Many popular definitions of ecotourism focus on the socioeconomics of Third World countries where much of the world's ecotourism industry exists. Since the present research occurs within an Australian national park, the definition of ecotourism that will be considered appropriate for this research is that of the EAA. The EAA's definition focuses directly on tourism within the Australian socioeconomic situation and is therefore more appropriate. Ecotourism, as defined by the EAA is "ecologically sustainable tourism that fosters environmental and cultural understanding, appreciation and conservation" (CDOT, 1994, p. 3).

Within this definition, the CDOT has further broken down four main elements required in ecotourism.

1. a natural element
2. an ecological and cultural sustainability element
3. an educative and interpretive element
4. an element based on local and regional benefits

(adapted from CDOT, 1994, pp. 16-17)

As a management strategy, this study will also consider a financial element. Although financial issues are mentioned throughout the four elements of the CDOT model, this study's emphasis on a management model requires finance be more closely examined.

4.1.1 A NATURE ELEMENT

The first of the elements involved in ecotourism is the nature element. Based on the idea that all ecotourism relies on the use of the natural environment, this element states that ecotourism must "[include] a focus on biological and physical features" (CDOT, 1994 p. 16).

4.1.2 AN ECOLOGICAL AND CULTURAL SUSTAINABILITY ELEMENT

The cultural and ecological sustainability element assumes that "ecotourism is managed to avoid or minimise negative impacts and to confer benefits on host communities and environments, for present and future generations" (CDOT, 1994, p. 16). It is with this wording that the WCED's influence becomes evident. The ideal of the needs for both

present and future generations in this section can also be found in the WCED's definition of sustainability.

4.1.3 AN EDUCATIVE AND INTERPRETIVE ELEMENT

Ecotourism must also have an educative and interpretive element. By attracting visitors interested in the environment, ecotourist activities should help to "develop [tourists] knowledge, awareness and appreciation" (CDOT, 1994, p. 17), of the environment and activity that they are involved in.

4.1.4 AN ELEMENT BASED ON LOCAL AND REGIONAL BENEFITS

The final element outlined in the CDOTs breakdown of ecotourism is that of local and regional benefits. It is this section that is often used to develop arguments regarding developed nations subordination of the Third World through tourism (Harrison & Husbands, 1996; Mowforth and Munt 1998; Honey, 1999). However, it is still very much relevant to tourism in an Australian context. Local and regional benefits that may be found in an Australian setting include "the use of locally based operators, the employment of local guides and use of specialised local training" (CDOT, 1994, p. 17).

4.1.5 FINANCIAL ELEMENT

Since the management of Crystal Cave is partially dependant of its own funding, the financial element is an important consideration.

Throughout this research, these five elements outline what will be deemed necessary for a project to be considered proper ecotourism.

4.2 CAN CRYSTAL CAVES' MANAGEMENT STRATEGY BE CONSIDERED A FORM OF ECOTOURISM

Having defined ecotourism and the elements necessary for an ecotourist based development, it now becomes essential to see whether or not the initial framework of Crystal Caves management strategy is suitably based on ecotourism. In order to be suitable, the management plan must contain aspects of all five elements. To begin this examination, a brief history of the development of the project will be included. The project will be examined to determine the effectiveness of the five elements outlined.

4.2.1 BEGINNINGS

The beginning of the Crystal Cave ecotourist based management strategy can said to have started as early as 1982, when Dr. Brenton Knott from the Zoology Dept. of the University of Western Australia (UWA) discovered the presence of "relictual subterranean crustaceans in some of the Yanchep caves" (Hillman, 2000, p. 7). Furthering Dr. Knott's work, Dr. Edyta Jasinska spent the years 1990-1997 further studying a number of these species, including the ones found in Crystal Cave.

Dr. Jasinska found that the species in Crystal Cave are an amphipod species in the genus *Hurleya*. Amphipods in the Cave are white and resemble miniature prawns. At less than 1-cm long, these creatures are eyeless and have long antennae. They are too large to burrow out of the Caves' stream, and exposure to light kills them. Dr. Jasinska

discovered that this species is a Gondwanan relic, present in this area from the time of Gondwana land, when the continents were attached and Australia was covered in a vast rainforest. (Hillman, 2000)

Brought to near extinction in the 1990's because of the drying of their habitat, these amphipods were "declared rare and endangered fauna [and] recovery management was initiated and a unique partnership between the WRC and CALM" (Hillman, 2000, p. 7) begun. The drying of the groundwater habitat was due to a drop in levels of the Gnamptogara Mound (see Figure 3), caused by climatic change, pine plantations (see Figure 5) and human groundwater extraction. From the outset, the Cave project has been aimed at "adopting ecotourism principles to preserve an endangered species, restore natural habitat and provide meaningful interpretation" (Hillman, 2000, p. 7) for visitors. With this emphasis on ecotourism, CALM rangers and the WRC have attempted to design a strategy that conforms to the four elements of ecotourism laid out by the CDOT. With the strong management implications, CALM ranger have also attempted to conform to the fifth, financial element included for this study.

4.2.2 A NATURE ELEMENT

Work done within Crystal Cave easily contains the first element of ecotourism. Formed thousands of years ago, the Cave draws people to "the beauty and curiosity of [its] natural formations, through the awesomeness of its dimensions and the power of the natural forces within [it]" (Jennings, 1983, p. 192). More than this however, the Cave work is being done in order to "allow the survival of [a] living fossil" (Jennings,

1983, p. 192), of unique biological properties, formed in this distinct environment and found nowhere else on earth.

4.2.3 ECOLOGICAL AND CULTURAL SUSTAINABILITY ELEMENT

Money earned from increased tourist numbers, as well as increased moneys earned from higher entrance fees to Crystal Cave have been earmarked to go directly into the continuation of the nature conservation program. Attempting to save this species and maintain groundwater levels allows for environmental benefits to the community for present and future generations. Also, maintaining tourism within the Cave promotes cultural benefits through first hand experience of an environmental rehabilitation program located in the local community.

4.2.4 EDUCATIVE AND INTERPRETIVE ELEMENT

Actions have already been put in place to conform to the third element. Much of the theme of Crystal Caves tour has already been changed to focus on the "importance of groundwater to natural areas and how peoples behaviours are important" (Hillman, 2000. p. 7), in protecting this resource. This acts to educate people in a local environmental problem and, in turn, raises their own personal awareness.

4.2.5 LOCAL AND REGIONAL BENEFITS

Local and regional benefits of the Cave project have been obvious from the outset. Firstly, the entire project is aimed at improving a natural area that remains accessible to all local and regional residents. This area

is within a national park and is therefore dedicated to recreational and educative benefits of the community. Secondly, efforts in the Cave project have been developed by regional agencies (WRC & CALM), and are run by local guides. Combined, this is a locally and regionally created project aimed at improving an element of the natural environment for local and regional recreational and educative benefits.

4.2.6 FINANCIAL

Due to the increased tourists expected from this project, and the increase in price of a tourist visit, the Cave project should earn enough funds to ensure that the amphipods will have "a sustainable future without relying on the vagaries of annual government grants" (Hillman, 2000, p. 7).

4.3 SUMMARY

While the term ecotourism appeared as early as 1980, it was not widely used until the early 1990's, when the WCED coined the popular phrase sustainable development and brought it to the world's attention. Ecotourism became the tourist industry's way of promoting these new environmental ideals. Political, social and commercial interests were effected by this new focus.

While numerous definitions have developed in the world, this paper has selected the EAA's interpretation, as ecologically sustainable tourism that fosters environmental and cultural understanding, appreciation and conservation. It is because of the EAA's goal of creating ecotourism in Australia's particular socioeconomic environment that this definition has

been chosen. The EAA's definition of ecotourism contains four main elements needed for a project to truly be considered to fulfil the goals of ecotourism. For this research, a financial element has also been included. The five elements needed for this project to be considered a model based on ecotourism are as follows

1. a nature element
2. an ecological and cultural sustainability element
3. an educative and interpretive element
4. an element based on local and regional benefits, and
5. a financial element

This chapter has examined the Crystal Cave project within these five elements and has identified compatibility with the elements of concern. With this said, it now becomes imperative that a detailed outline of the Cave project be given.

CHAPTER 5: CRYSTAL CAVES ECOTOURIST BASED MANAGEMENT STRATEGY

Given Crystal Cave project contains all five elements considered necessary for an ecotourist based model of development, it is necessary to address the project currently underway intended to maintain a sustainable environment. This chapter examines works that have occurred in and around the Cave, aimed at restoring the previous water levels. In addition, the pilot project currently in progress within Crystal Cave will be reviewed within the context of the study.

5.1 EARLY EFFORTS DEVELOPED OUTSIDE CRYSTAL CAVE

Before any work could be started within Crystal Cave, a number of actions were taken in the area surrounding Yanchep National Park. These actions were developed in order to begin the long process of naturally restoring previous groundwater levels within the Gnangara Mound. Two of the most influential of these actions included the thinning of pines surrounding the Park, and the adoption of more responsible water extraction for human use in the region.

Pine plantations surrounding Yanchep are known to be the primary extractor of groundwater in the region which causes significant lowering of the water table. Not being a native species, "*pinus pinaster* originates from the Mediterranean" (National Library of Australia, 1997, p. 14) regions, and requires a great deal of water for survival. Because of this, a Memorandum of understanding is now being finalised between the WRC and CALM, aimed at returning the area to its natural woodland. Natural

woodland is far more suited to the environment and puts a great deal less stress on the water table.

Because of this Memorandum, one initial step was also taken inside Crystal Cave. This was the introduction of piezometers (see Plate 5.0). A piezometer is a hollow plastic tube that is sunk into the earth 1 to 2 meters. Because this tube is hollow, water is able to flow freely upwards without the overhead pressure of sand or earth. Probes are then inserted into the tube to obtain an accurate measure of water depth beneath the surface. Piezometers were put in Crystal Caves floor in order to measure the water table recovery as a result of thinning the pines. It is these piezometers that have been used throughout the Crystal Cave pilot project to correctly plot underground water levels/pressure. Knowing levels and pressure of water under the earth has allowed CALM rangers to determine the amount of water needed to sustain certain water levels in individual pools of the Cave, as well as the entire Cave (see Appendix 2a, b, c).

In addition, restrictions on extraction of groundwater for human use have also been developed in the region (see Plate 5.1). It is expected that this increased awareness will encourage more responsible water use. Combined, these two measures taken outside the Park have been developed with the long term goal of groundwater restoration in mind. Having addressed the groundwater issue in the region surrounding the Cave, the project turned the focus on the amphipods immediate needs within the Cave.

PLATE 5.0

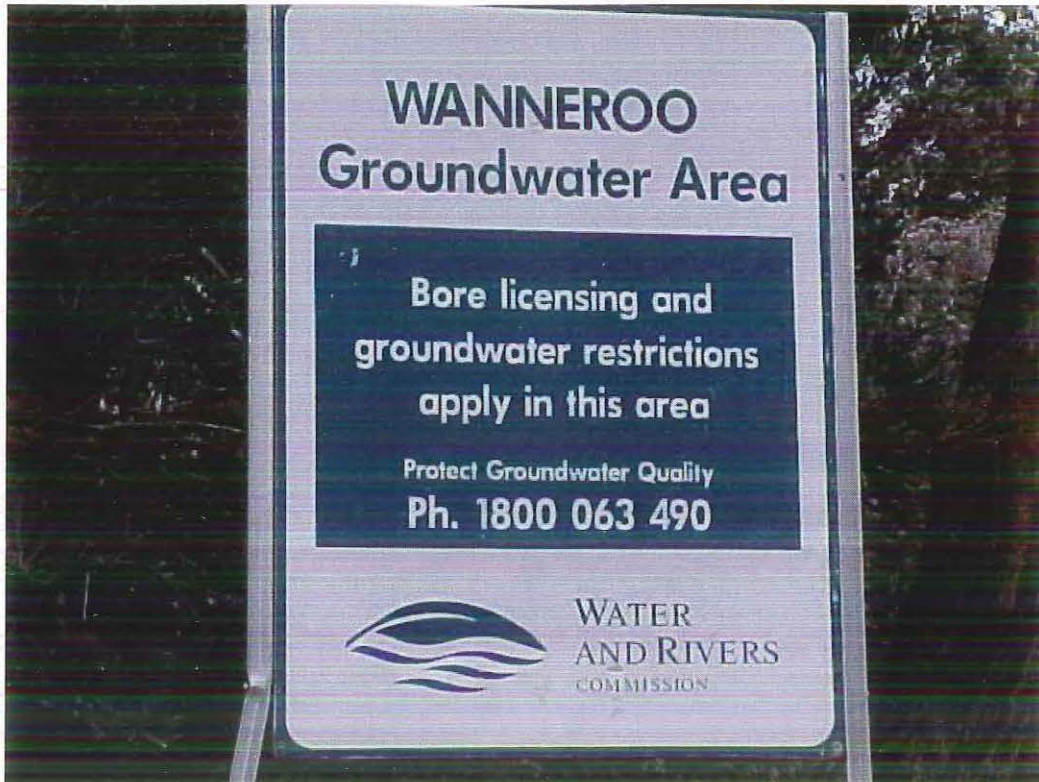


PIEZOMETERS LOCATED AT POND 1

Source: Personal Photograph

Plate 5.0: This photograph shows the two white plastic piezometers originally located at the originally dug pond in Crystal Cave. Photograph taken by author 20 July 2000.

PLATE 5.1



**EXAMPLE OF GROUNDWATER MEASURES TAKEN IN THE
GNANGARA MOUND REGION**

Source: Author

Plate 5.1: This photograph represents one of the original measures taken in the Gnamara Mound region aimed at lessening human use of water in the region. Photograph taken approximately 200 meters from the entrance of Yanchep National Park. (July of 2000).

5.2 EARLY MEASURES INSIDE CRYSTAL CAVE

Obviously, waiting for groundwater levels to naturally regenerate within Crystal Cave was impossible to meet the amphipods needs. Hence, work to save the species began inside Crystal Cave in late 1999. The first official work done within the Cave was the addition of two fish tanks inside the Cave (see Plate 5.2). These tanks provided a large, safe environment in which the amphipods could temporarily survive. After the amphipod population was transported to the tanks, a pond was dug into the Cave floor (pond 1) near the Pantheon section (See Figure 7 & Plate 5.3). This original pond was not lined to expediate this transfer. Two additional ponds were than dug into the Cave floor (pond 2 & pond 3) (see Figure 7). With more time for completion, these ponds were lined, and each had a soak well located adjacent to it (see Plate 5.4). A soak well is a pump dug into the Cave floor that supplies the ponds with the needed groundwater, ensuring that the ponds do not dry up. These soak wells were programmed to provide very slow flow rates of ten minute bursts of water, four times a day. Short bursts of water are preferred in this situation as they limit the sand erosion within the ponds. Eventually, water quality tests within the ponds demonstrated that water was being maintained in a favourable condition for the amphipods. The next steps could then be taken.

PLATE 5.2 (a)



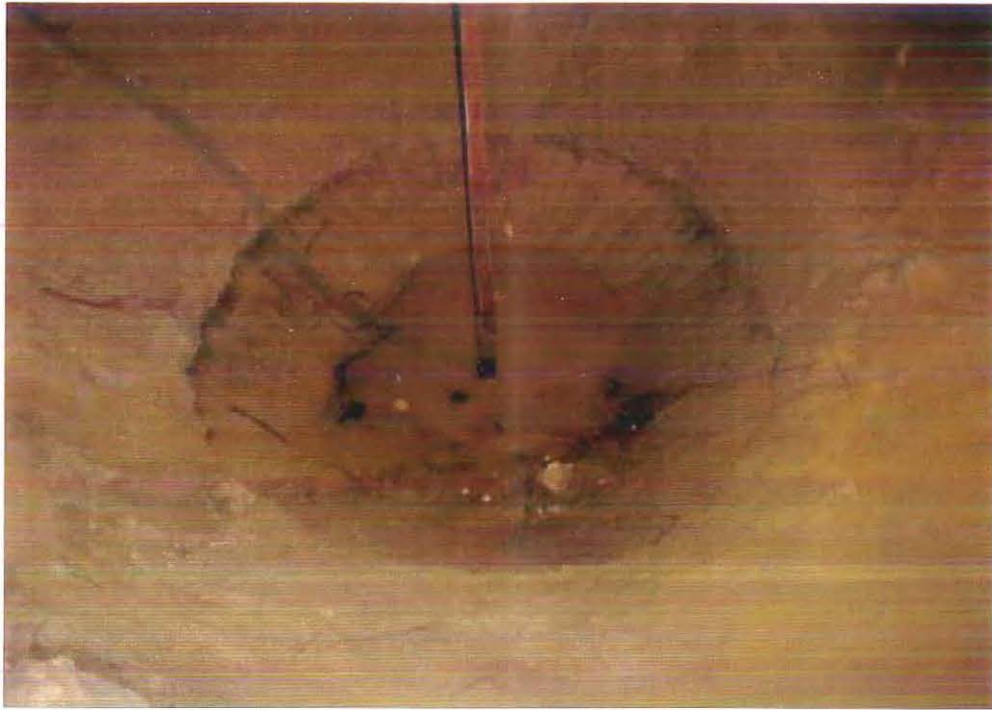
PLATE 5.2 (b)



Source: Photographs acquired from Paul Tholen, ranger in charge of Cave project

Plates 5.2 (a) and (b): These photographs are taken from within the Cave and show the fishtanks used to provide the amphipods with an artificial environment. Photographs taken by Paul Tholen at an unknown date.

PLATE 5.3

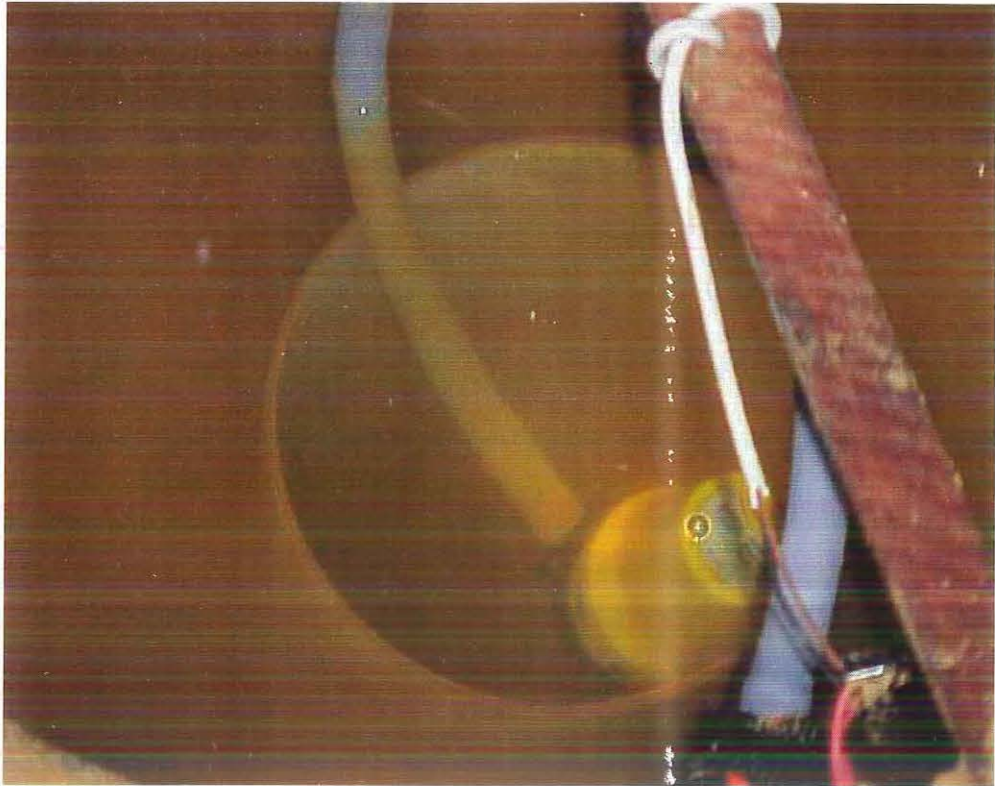


INITIAL POND DUG IN FLOOR OF CRYSTAL CAVE

Source: Author

Plate 5.3: Photograph taken showing the original pond dug in order to provide amphipods with access to natural water environment as groundwater levels began to deplete. (June 2000).

PLATE 5.4



EXAMPLE OF SOAK WELL USED IN CRYSTAL CAVE

Source: Author

Plate 5.4: Photograph showing a soak well in Crystal Cave. The soak well is a pump used to ensure specific water levels in the Cave while limiting the amount of sand allowed in the pond. (15 September 2000).

5.3 INTRODUCTION OF THE AMPHIPODS TO THE PONDS

On February 26th, 2000, amphipods from pond 1 were transferred into the two lined ponds (pond 2 & pond 3). Dr. Edyta Jasinska decided that the most pertinent number of amphipods to be introduced should be three females and three males into each of pond 2 and pond 3. These amphipods were then monitored for a number of weeks until it was determined that they could survive in the man made ponds. With the successful introduction of these species to the ponds (all survived), it was decided that additional amphipods could be introduced into the ponds. The number of amphipods were doubled so that there were twelve creatures in each of the ponds, six males, and six females.

5.4 ADVANCING WITH THE PILOT PROJECT

A number of factors have convinced CALM rangers that the pilot project should proceed, a primary factor being that the lined ponds are clearly able to sustain the amphipods. More importantly, water levels within the Cave continue to drop, seriously threatening the amphipods.

The first step in preparing the test pilot was the allocation of a site. For the test pilot, a large, easily accessible section of the Cave was required. For this, Pantheon section of the Cave was chosen (see Figure 7). Not only is Pantheon section easily accessible, but

“both the depth to water table and the Hydrolic Conductivity represent the average of the Cave, and the total surface area of this one pond represents one half the total surface area requiring filling.”

Source: Paul Tholen. (2000) Proposal to Supplement
Crystal Cave Stream Pool [on-line].
Available E-mail: {leonieh@CALM.wa.gov.au}.

In order to prepare the Pantheon section for flooding, the Cave floor of this section had to be levelled. This was done in order to maintain water depth and ensure equal water allocation throughout the area. It is also important to note here that unlike test pools 2 and 3, the Pantheon pond was not lined prior to its flooding. Omitting liners creates a replicated environment as natural as possible and ideal for ongoing projects as it contains fewer introduced elements. Once this test pilot has been completed, a review will be carried out to determine whether liners are necessary, or whether future projects in the Cave may be completed without them. Once Pantheon was prepared for flooding, two water needs had to then be determined, a source of water had to be found; and, a transportation method for that water to the Cave had to be developed.

5.5 WATER NEEDS

5.5.1 SOURCE

Since the Pantheon section of Crystal Cave is over 200 times the size of the original pond (see Appendix 2), a source of water needed to be located that would not depend on the depleting groundwater currently supplying the smaller pools. In addition, this water source also requires key physical, chemical and biological (species composition of the water) parameters in order to ensure the amphipods survival. To locate such a source, ten samples of groundwater were taken from various areas throughout the Park and tested for the proper chemical and biological factors Alkalinity, CO_3 , Ca, Cl, Cr, Cu, Econd, Fe, HCO_3 , Hardness, K, Mg, Mn, N-NH_3 , N-NO_3 , Na, Ni, P total, Pb, $\text{SO}_4\text{-S}$, Zn, ionic balance and pH factors were all analysed at the Chemistry Centre of Western

Australia, while Dr. Edyta Jasinska herself analysed the compositions required for the biological species. Of all the samples, a source called Lakeside Bore (YN8) (see Figure 8) was determined to have the acceptable water chemistry and biological species composition to be used for the test pilot. Also, YN8 was found to provide sufficient water to supply both the test pilot, as well as existing needs of the Park (see Table 2). An additional source, the North Oval Bore (YN4) (see Figure 14) was also found acceptable in the event that YN8 could not provide the necessary water needs.

TABLE 2 a RECREATIONAL WATER USE IN YANCHEP NATIONAL PARK VS. WATER SUPPLY FROM YN8

FROM TOP (m)	TIME	VOLUME (m)	VOLUME DECREASE (m)	DECREASE L/HR.
0.4	8:30 a.m.	77940	14300	
0.56	10:30 a.m.	72220	5720	2860
0.66	11:23 a.m.	68640	3580	4050
0.85	1:54 p.m.	61850	6790	2700
0.89	2:30 p.m.	60420	7430	2380
1.05	5:15 p.m.	54700	5720	2540
1.21	7:40 p.m.	48980	4290	1780
1.33	9:30 p.m.	44690	4290	2320
1.45	11:25 p.m.	40400	4290	2240
1.83	5:25 a.m.	26810	13590	1940

Average Increase per Hour: 2280L
Average Decrease per Day: 54720L

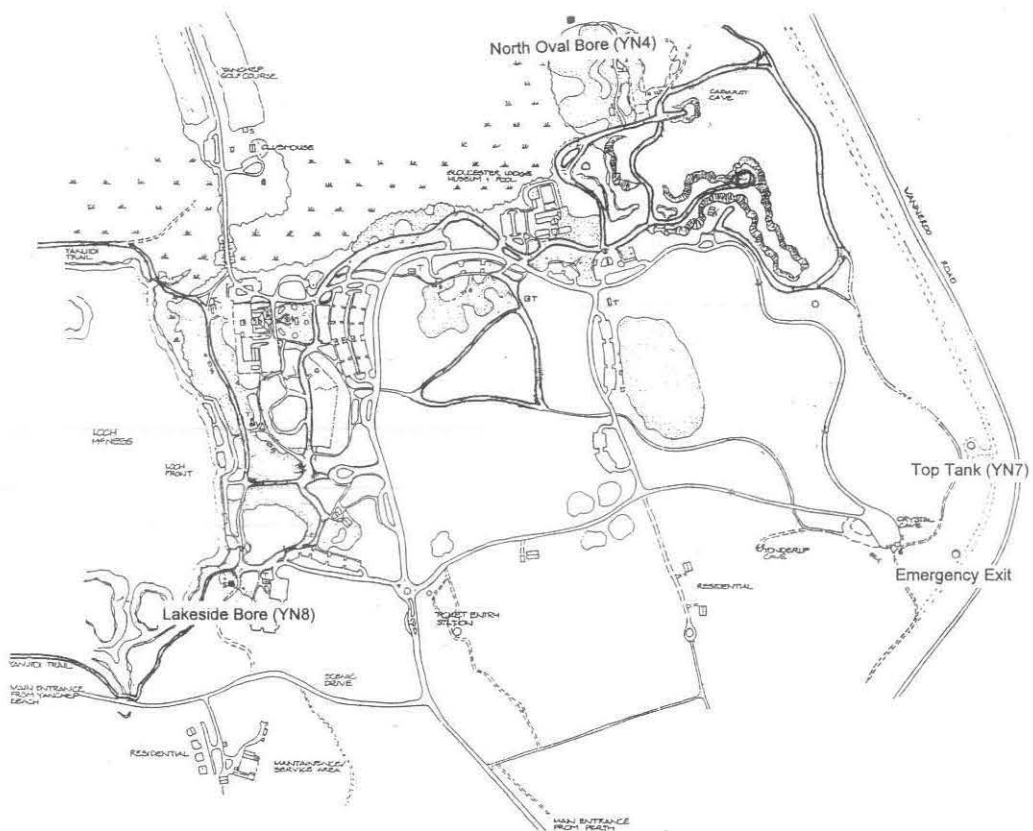
TABLE 2 b WATER SUPPLY FROM LAKESIDE BORE

FROM TOP (M)	TIME	VOLUME (m)	VOLUME DECREASE (m)	DECREASE L/HR.
1.83	5:25 a.m.	26810		
1.26	7:45 a.m.	47190	20380	11490
0.68	9:48 a.m.	67930	20740	9940
0.26	11:20 a.m.	82940	15010	6820

Average Increase per Hour: 9420L
Average Increase per Day: 226080L

Source: Personal files of Paul Tholen, CALM ranger in charge of Crystal Cave project

FIGURE 8



**KEY LOCATIONS FOR CRYSTAL CAVES WATER
SUPPLEMENTATION**

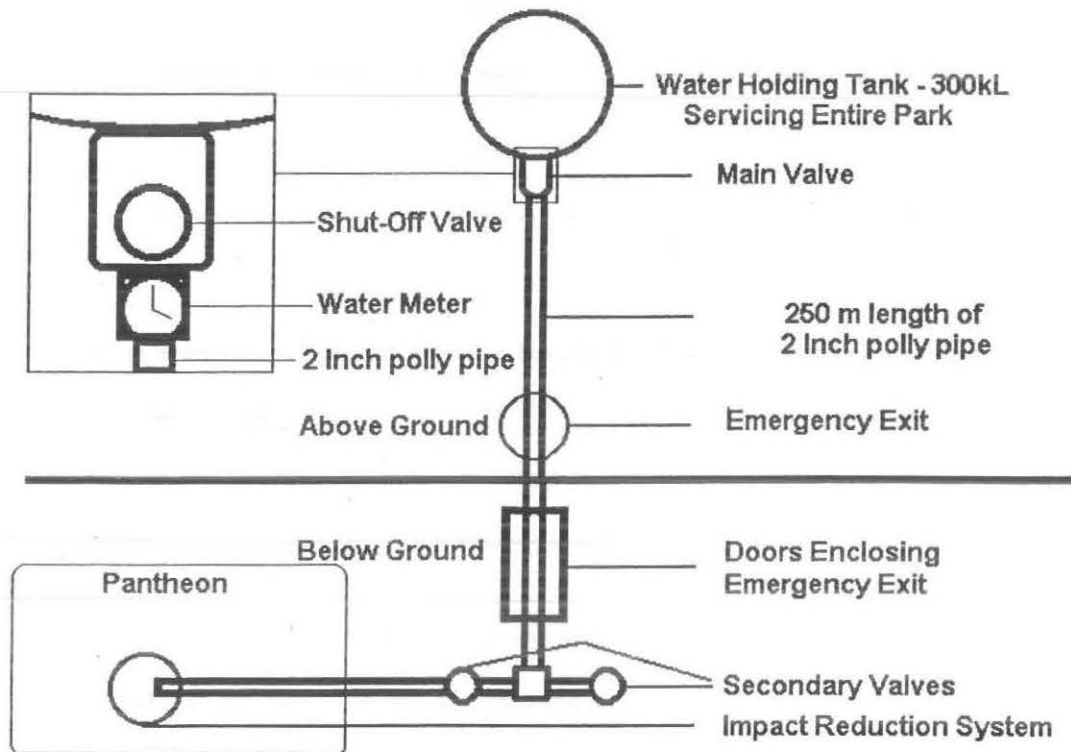
Source: Department of Conservation and Land Management. (Ed.). (1989).

5.5.2 TRANSPORT

With a suitable water source found for the test pilot, work then focused on a method of transporting water from YN8 to the Cave. This task proved a relatively simple one, as water from YN8 was already being pumped under pressure to a storage tank near Crystal Cave called Top Tank (YN7) (see Figure 8). It was this pressurised piping that provided a water source for the Cave. A T joint was added to this piping in order to transport water through 2 inch poly piping towards Crystal Cave. As this piping is pressurised, a shut off valve and water meter were added at this T joint in order to adjust flow and monitor volume of water entering the Cave (see Figure 9 A). From this T joint, water is to be piped 250 meters (see Figure 9 B) to the location of the emergence exit of the Cave (see Figure 7), where a 90° angle will allow water to travel the 30 meters down to the bottom of the Cave. Reaching the Cave floor, water will encounter another T joint which leads to the Pantheon section of the Cave, as well as the Jewel City section that will be developed in the future. During the test pilot, the pipe to Jewel City will be closed. Another shut off valve will be located at this second T joint for further control over water flow into the Cave (see Figure 9 C). From this point, piping will travel the last 32 meters underground in order to reach its final destination, the centre of the Pantheon. A soak well will also be located in the Pantheon section, and will have a limestone base. This will be used to reduce water from eroding the sandy floor of the Pantheon.

Having prepared the Pantheon section, and the water supply system, the test pilot will be ready and flooding can commence.

FIGURE 9



CRYSTAL CAVE WATER SUPPLEMENTATION SYSTEM

Source: Personal files of Paul Tholen, CALM ranger in charge of Crystal Cave project

5.6 MONITORING

Once initial flooding of the Pantheon occurs, the test pilot will monitor results for the duration of one week. Over this week, a number of different variables will be measure in order to determine the sustainability of the project and survival of the amphipod species. These variables include turbidity of the water, pond hight fluctuations, effect upon existing ponds throughout the Cave, water chemistry and flow rates. Also during the initial week, YN7 and YN8 will be monitored. However, unlike Pantheon, both the tank and the bore will be monitored for fluctuation in water availability. This will be done to determine the long term viability of the project.

5.7 SUMMARY

A number of efforts have been made in the Gngangara Mound region in order to start the regenerative process of the water table. Outside of Yanchep National Park, the thinning of pine plantations, development of water use restrictions, and the raising of peoples awareness towards the water problems have all been aimed at the eventual regeneration of the regions groundwater to its original levels. All of these measures however, will take far too long to ensure the survival of the amphipods that reside within Crystal Cave. It is for this reason that the ecotourist based management strategy within the Cave has begun, aimed at temporarily flooding of sections the Cave until water table levels can be restored. Before the project can commence however, a number of initial actions had taken place within the Cave. These actions included the introduction of

fish tanks for temporary storage of the species, the development of artificial lined ponds, and the eventual introduction of species to those ponds.

Now, given the stunning success of the species within these artificial ponds, a much larger test pilot has been developed within the Pantheon section of the Cave. Involving a great deal of work inside the Cave, and the development of a sophisticated pumping system outside the Cave, success of this pilot project will determine whether CALM rangers commence with flooding the entire area previously under water within Crystal Cave. It is also this test pilot that my thesis is focused upon.

The next chapter of this thesis will actually involve the evaluation of the ecological and financial success of this project as I have analysed it. The following chapter will analyse visitors feeling towards the project. From this, a final chapter will produce the conclusions of the ecotourist based management strategy in Crystal Cave.

CHAPTER 6: QUESTIONNAIRE ANALYSIS

In order to gain the tourists appreciation of the Crystal Cave tour, a questionnaire was developed (see Appendix 1) and distributed to participants of the Cave tour. The following chapter is the analysis of the responses, and will be used to develop an understanding of peoples appreciation towards the ecotourist based management strategy occurring within Crystal Cave.

6.1 DISTRIBUTION

Visitors to Crystal Cave were informed as to the availability and purpose of the questionnaire before participating on the tour. Upon completion of the tour, questionnaires were made available to those patrons willing to participate. In doing this, distribution of the questionnaire was carried out in the least intrusive manner. Distribution of the questionnaire was conducted on two separate occasions in the month of July. This was done to obtain a larger number of participants, and to ensure responses were given with different tour guides.

Originally it was hoped that one distribution day would occur prior to the project, and one after. Due to delays in the pilot project, this goal was not feasible and both distribution days occurred before completion of the pilot project. The study will now focus on an analysis of the ecotourist based management strategy in progress.

6.2 ANALYSIS

Having completed the distribution and collection of the questionnaires, an SPSS program was used to calculate frequencies, percentages, valid percentages, and cumulative percentages of participants responses (see tables 3-20). In total, 78 questionnaires were found valid for use in this analysis. The qualitative analysis of visitors questionnaires throughout this chapter will be based on those 78 questionnaires.

Analysis of SPSS results is based on straight percentages of participants results. For reliability, only percentages of 60% or higher will be regarded as having relevant significance. However, cumulative results will often be combined to show either positive, or negative trends.

6.3 SECTION A

There were four general sections to be completed throughout the questionnaire. The first section (section A) was aimed at discovering the general demographical information of tour participants, as well as their motivations for participation in the tour.

Questions were,

1. Where is your current residence?
2. What is your current age?
3. What is your motivation for visiting Yanchep National Park today?
4. What is your motivation for visiting Crystal Cave?
5. Is this your first visit to Crystal Cave?

Question 1 (see Table 3) of section A reveals that 64.1% of visitors to Crystal Cave live in the region considered local. In this thesis, I have designated both Yanchep/Wanneroo, and Perth as being local to the Park. Local was considered when travel to Yanchep from the location involved no overnight accommodations and was easily considered a day trip. The trends of local rather than international tourism should not be surprising, given that the "overwhelming majority-approximately 90%- of tourists in Western Australia live in Western Australia" (O'Brien, 1989, p. 29). However, it is interesting to note that nearly 18% of visitor to Crystal Cave are in fact international. Only 9% of these visitors were on organised tours (see Table 6). It is encouraging to see that almost 10% of total visitors are international and not on a tour. This trend can only be explained through either well developed advertising in the Perth tourist area, or because regional people have found the Park and/or Crystal Cave a trip worth encouraging travellers to visit.

TABLE 3

CURRENT RESIDENTS OF QUESTIONNAIRE RESPONDENTS

Residence	Frequency	Percent	Cumulative Percent
Yanchep/Wanaroo	7	9.0%	9.0%
Perth	43	55.1%	64.1%
Elsewhere in W.A.	6	7.7%	71.8%
Elsewhere in Australia	8	10.3%	82.1%
International	14	17.9%	100%
Totals	78	100%	

Although over 60% of tourist to Crystal Cave are local, there would appear to be a positive trend towards international tourism. And since many international visitors are not on organised tours it may be proposed that increased word of mouth advertising by pleased local tourists has fostered this development.

The second question of section A, regarding visitors age (see Table 4), again showed a positive response in regard to Crystal Caves tourism. Tourists to the Cave represent no significant age category. However, participants over 60 years old only consist of 6.4% and the 31-40 and under 20 year old categories combine to make 57.7%. From these results, it can be assumed that there are a high portion of parent/child and/or family visitation. The two groups that do not generally fall into the family category (21-30 and over 60) consisting of the lowest percentages of visitors.

TABLE 4

AGE OF RESPONDENTS

Age	Frequency	Percent	Cumulative Percent
Under 20 years old	18	23.1%	9.0%
21-30	14	17.9%	41.0%
31-40	27	34.6%	75.6%
41-60	14	17.9%	93.6%
Over 60 years old	5	6.4%	100%
Totals	78	100%	

This response is very positive as it not only demonstrates how adults have found the tour interesting, but that they feel the tour is a

worthwhile experience for children. It is expected that these children will also return, possibly with their own families in the future.

The family orientation of the Cave tour is again revealed by the responses to the third question (see Table 5), concerning peoples motivation to visit the Park. Only fifty kilometres from Perth, Yanchep National Park provides an easily accessible day trip option for families residing in the city. With 44.9% of visitors to the Cave travelling to the Park for the Cave tour, and another 24.4% visiting for either a picnic or barbecue, Yanchep appears to be highly frequented for what would be considered as family oriented activities.

TABLE 5

RESPONDENTS MOTIVATIONS FOR VISITING YANCHEP N. P.

Motivation	Frequency	Percent	Cumulative Percent
Caves	35	44.9%	44.9%
Wildlife	14	17.9%	62.8%
Picnic/BBQ	19	24.4%	87.2%
Lodge or Museum	0	0%	87.2%
Golf/recreation	1	1.3%	88.5%
Other	9	11.5%	100%
Totals	78	100%	

Of most concern to an ecotourist based management strategy however, is peoples' motivations for visiting Crystal Cave itself (see Table 6). It is clear that the primary motivation for respondents visitation is in the interest of nature (48.7%), while only 7.7% of visitors to Crystal Cave have been motivated to visit because of positive comments from others. This figure is less than expected and generates concern since "word of mouth

is one of the most common information sources in the area of nature based tourism" (Blamey, 1995, p. 4), including ecotourism. It is also one of the most effective, and important forms of advertising, and therefore highly sought after in the tourism industry. It is anticipated that returning visitors will speak positively of their experience as a result of the Cave project, encouraging future participants. With the project still under way, and tours only recently emphasising efforts to save the amphipods, it is assumed that word of mouth advertising on the project may not have had a chance to be generated at this point. Since 48.7% of visitors take the tour in the interest of nature, it is anticipated that tourism will increase with continued efforts to save such an endangered species. With 17.9% of visitors motivated because of past enjoyment, it is hoped that this number will increase with repeat visitors wanting to know how the project has progressed and see whether or not it been successful.

TABLE 6

RESPONDENTS MOTIVATIONS FOR VISITING CRYSTAL CAVE

Motivation	Frequency	Percent	Cumulative Percent
It is on the tour	7	9.0%	9.0%
Interest in nature	38	48.7%	57.7%
Had heard good things	6	7.7%	65.4%
Had enjoyed it previously	14	17.9%	83.3%
Heard about project occurring	1	1.3%	84.6%
Other	12	15.4%	100%
Totals	78	100%	

Finally, question 5 again shows the apparent lack of word of mouth advertising for the Cave tour (see Table 7). Only 25.5% of visitors on the Crystal Cave tour are first time visitors. With word of mouth advertising expected to rise in the near future, so too should the number of people interested in the Cave. Improvements, however, need to be made in regards to word of mouth advertising of Crystal Cave. With under 10% of visitors to the Cave motivated in this way, great improvements can be made. Since the ecotourist based management strategy is still in its infancy, responses to this question are perhaps premature.

TABLE 7

WAS THIS RESPONDENTS FIRST VISIT TO CRYSTAL CAVE?

First Visit?	Frequency	Percent	Cumulative Percent
Yes	48	61.5%	61.5%
No	23	29.5%	91.0%
Yes, in 20 years	7	9.0%	100%
Totals	78	100%	

6.3.1 SECTION A SUMMARY

Responses to section A demonstrate that the demographic group visiting Crystal Cave are mainly young, local families. With over 60% of visitors from the local region, and most with young families visiting the Park to see the Cave or have a barbecue, Yanchep National Parks family focus is evident. More relevant to this study on an ecotourist based management strategy is that only 9% of participants visited the Cave because of word of mouth advertising, and only 29% are first time visitors.

It is expected that the project within the Cave will positively effect a change and attract newcomers through hearsay. With nearly half of respondents visiting the Cave in the interest of nature, it is likely that word of mouth advertising will increase. By directing the focus of the Cave tour towards the projects environmental and aesthetic benefits, positive impressions should also be developed in these same tourists

6.4 SECTION B

Section B of the questionnaire was developed to determine participants general feelings towards the Crystal Cave tour itself. Key to this section is participants willingness to visit the Cave, and/or recommend the tour to others.

Questions in this section were

1. Would you visit Crystal Cave if in Yanchep National Park again?
2. If in Perth, would you return to Yanchep in order to see Crystal Cave again?
3. Would you recommend the Crystal Cave tour to someone you know was visiting Yanchep National Park?
4. Overall, how would you rate your visit to Crystal Cave?

In response to willingness to visit Crystal Cave again (see Table 8), a very positive 67.9% of respondents would either definitely (32.1%) or probably (35.9%) return to the Cave if in Yanchep National Park. To offer further positive support is the fact that only 6.4% of respondents would either not return (3.8%) or would be doubtful to return

(2.6%). It is obvious here that the Crystal Cave tour does have a positive effect on tourists in the terms of generating repeat tourism. This helps to explain why so many visitors are already repeat visitors.

TABLE 8

WILLINGNESS OF RESPONDENTS TO VISIT CRYSTAL CAVE IF AGAIN IN YANCHEP

Would respondent visit Crystal Cave if in Yanchep?	Frequency	Percent	Cumulative Percent
Definitely	25	32.1%	32.1%
Probably	28	35.9%	67.9%
Maybe	20	25.6%	93.6%
Doubtful	2	2.6%	96.2%
No	3	3.8%	100%
Totals	78	100%	

Question 2 of this section also drew generally positive results (see Table 9). Although only 52.6% of respondents would definitely (20.5%) or probably (32.1%) return to Yanchep in order to see the Cave, a further 30.8% gave an answer of maybe. This means that only a small portion of visitors (16.7%) would either doubtfully return to see the Cave (10.3%), or not return to see the Cave (6.4%), again demonstrating a hopeful future increase in repeat visitors.

TABLE 9

**WILLINGNESS OF RESPONDENTS TO RETURN TO CRYSTAL CAVE
IF IN PERTH**

Would respondent visit Crystal Cave if in Perth?	Frequency	Percent	Cumulative Percent
Definitely	16	20.5%	20.5%
Probably	25	32.1%	52.6%
Maybe	24	30.8%	83.3%
Doubtful	8	10.3%	93.6%
No	5	6.4%	100%
Totals	78	100%	

The most positive responses of section B came in question 3 (see Table 10). As section A demonstrated, word of mouth advertising is one of the elements that definitely needs to be addressed if the project is going to be successful. Question 3 positively supports word of mouth advertising in the future. A clear 92.3% of participants expressed that they would definitely (69.2%) or probably (23.1%) recommend the Cave tour and only 1.3% stated they would doubtfully recommend it. This is extremely important to a project such as the one occurring in Crystal Cave, as "business arising from positive word of mouth may constitute the most valuable return from customer satisfaction" (Blamey, 1995, p. 3). Such high proportions of people willing to recommend this tour have hopefully been created through the increased emphasis on the project. This would suggest that the numbers of visitors attracted to the Cave by word of mouth should substantially increase in the future.

TABLE 10

WILLINGNESS OF RESPONDENTS TO RECOMMEND CAVE TOUR

Would respondent recommend Cave tour to someone visiting Yanchep?	Frequency	Percent	Cumulative Percent
Definitely	54	69.2%	69.2%
Probably	18	23.1%	92.3%
Maybe	5	6.4%	98.7%
Doubtful	1	1.3%	100%
No	0	0%	
Totals	78	100%	

The final question in section B, question 4, related to respondents overall feelings about the tour (see Table 11). Here, 46.2% of participants indicated that the tour was excellent, and 48.7% said the tour was very good. No participants feel the tour was unsatisfactory. With the Cave project aimed at not only improving the environmental situation of the Cave environment, but the aesthetic as well, many of the good and average responses have the potential to become excellent with future aesthetic improvements. As with questions regarding word of mouth advertising, it would have been beneficial had a portion of the surveys been done after completion of the pilot project.

TABLE 11

RESPONDENTS OVERALL RATING OF CAVE TOUR

Rating of Cave tour	Frequency	Percent	Cumulative Percent
Excellent	36	46.2%	46.2%
Good	38	48.7%	94.9%
Average	4	5.1%	100%
Bad	0	0%	
Terrible	0	0%	
Totals	78	100%	

6.4.1 SECTION B SUMMARY

Responses to people feelings about the Cave tour were all very positive. Nearly 79% of respondents were receptive to a return visit to Crystal Cave if in Yanchep, and over 90% of respondents either definitely or probably would recommend the tour to others. This supports an increase with numbers of tourists visiting in the near future. The relationship to such enthusiasm due to the Cave project will be later analysed in section D. What is important to note in this section is that with the changes made to the Cave tour, 0% of people rated their experience as negative, and a very positive 94.9% rated it as either excellent or good.

6.5 SECTION C

Having determined the tour as a positive experience for participants, questions on whether or not the tour is worth the price of admission were asked in section C.

Questions were

1. Do you believe the Crystal Cave tour is worth the price of admission?
2. Do you believe that work being done in Crystal Cave should be paid for by incoming tourist dollars (as opposed to government grants)?
3. Overall, do you feel that work being done within Crystal Cave is worth the money being put into it?

In question 1, participants indicated (see Table 12) that the Crystal Cave tour is in fact worth the price of admission. Although only 14.1% of people were surprised with what they experienced, another 76.9% were pleased and only 9% were disappointed. Given that the "prices people are willing to pay [are] indicators of intensity and of feeling" (Industries Assistance Commission, 1989, p. 33), this result is very positive, especially when considering that the price of admission nearly doubled ten months earlier. Prices rose from \$2.00 to \$5.00 for adults, and \$0.50 to \$2.00 for children.

TABLE 12

RESPONSES GIVEN REGARDING PRICE OF ADMISSION

Is tour worth admission price?	Frequency	Percent	Cumulative Percent
Surprised with value	11	14.1%	14.1%
Pleased with value	60	76.9%	91.0%
Disappointed with value	7	9.0%	100%
Displeased with value	0	0%	
Totals	78	100%	

What must also be considered positive here is that these surveys were conducted one week after the introduction of the GST, which also raised prices of the tour unexpectedly from \$5.00 and \$2.00 to \$5.50 and \$2.50 for adults and children respectively.

The second question in section C also produced positive results for an ecotourist based management strategy (see Table 13), with 62.8% of participants believing that work in the Cave should either definitely (26.9%) or probably (35.9%) be paid for by incoming tourist dollars. Of the other

37.2%, only 19.2% of respondents responded negatively indicating that tourist dollars should not be used. The other 17.9% were maybe.

TABLE 13

SHOULD CAVE PROJECT BE PAID FOR WITH TOURIST DOLLARS?

Should project be paid for using tourist dollars?	Frequency	Percent	Cumulative Percent
Definitely	21	26.9%	26.9%
Probably	28	35.9%	62.8%
Maybe	14	17.9%	80.8%
No	15	19.2%	100%
Totals	78	100%	

A positive response here is needed for an ecotourist based management strategy. Financial sustainability of this project will be based on not having to rely on government grants, which are often unreliable and can be difficult to obtain. On the other hand, tourist numbers to Crystal Cave have always been high, and increased tourist income would help assure the success of the pilot project in the future.

Another financially positive result was obtained in question 3 (see Table 14) as 92.3% of participants indicated that the project is either definitely (61.5%) or probably (30.8%) worth the money being put into it. Again, being an ecotourist based strategy, positive feeling from the tourists themselves are important in all aspects of the project, including financial.

TABLE 14

RESPONSES REGARDING FINANCIAL INVESTMENT OF PROJECT

Is Cave project worth financial investment?	Frequency	Percent	Cumulative Percent
Definitely	48	61.5%	61.5%
Probably	24	30.8%	92.3%
Maybe	5	6.4%	98.7%
No	1	1.3%	100%
Totals	78	100%	

6.5.1 SECTION C SUMMARY

One of the most critical aspects to any ecotourist based management strategy is finance, especially in a project such as the one in Crystal Cave that requires a great deal of materials, labour and scientific input. In the Case of Crystal Cave, there does not seem to be any danger of loosing visitor numbers for financial reasons, as 91% of respondents were pleased or surprised with the value of the tour. Combined with the 62% of visitors who think that tourist dollars should either definitely or probably be used instead of government grants, and over 92% of visitors that think the project is definitely or probably worth the money, all make the financial aspects of the Cave appear quit positive.

6.6 SECTION D

The final section of the visitor questionnaire was developed to ascertain participants feelings for the pilot project itself.

Questions were

1. What had you heard about the species and/or project to restore water levels in Crystal Cave?
2. Do you feel that enough information is provided about the species and project to restore water levels in Crystal Cave?
3. How would you rate the tour guides manner in being helpful and knowledgeable with regards to the project and species within Crystal Cave?
4. Is the Crystal Cave project safe for the environment
5. Is this project going to improve Crystal Caves ecological value?
6. Is the work being done within Crystal Cave going to improve its aesthetic value?
7. Will the work within Crystal Cave attract tourism by rejuvenating water levels and/or saving the species?

It was determined that question one of section D was poorly worded. Participants did not know whether or not the question applied to before or after they had taken the tour. It is for this reason that question 1 is considered inappropriate and is not included in this analysis.

One of the key aspects to an ecotourist based management strategy is that it "attracts people who wish to interact with the environment

and, in varying degrees develop their knowledge, awareness and appreciation of it" (CDOT, 1994, p. 17). Participants in the Crystal Cave survey responded as ecotourists are expected in question 2 (see Table 15), as 94.9% of people expressed that they would have liked more information on the project (a lot more 39.7%, a little more 55.1%). This strengthens the goal of the Cave project as people are showing that they do have a strong interest in it. Results such as this show that the increased emphasis of the tour on the amphipods is appreciated and should be further strengthened.

TABLE 15
RESPONDENTS ANSWERS REGARDING AMOUNT OF INFORMATION PROVIDED ABOUT PROJECT

Is there enough information provided on tour?	Frequency	Percent	Cumulative Percent
Wanted a lot more	31	39.7%	38.7%
Wanted a little more	43	55.1%	94.9%
A little too much provided	3	3.8%	98.7%
Far too much provided	1	1.3%	100%
Totals	78	100%	

Question 3 of this section reveals a great deal as to why people showed such a positive interest (see table 16). One of the key elements needed in an ecotourist based project of any kind is "appropriately qualified guides" (CDOT, 1994, p.17) able to provide an enjoyable experience. In the Crystal Cave example, 87.2% of participants felt their guide was either excellent (55.1%) or good (32.1%), and only 1.3% (or one individual) rated their guide under the satisfactory level. One of the

best elements to any tour is good guides, which question 3 identifies in Crystal Cave.

TABLE 16

RESPONDENTS RATING OF TOUR GUIDES KNOWLEDGE ABOUT PROJECT

Tour guides rating	Frequency	Percent	Cumulative Percent
Excellent	43	55.1%	55.1%
Good	25	32.1%	87.2%
Satisfactory	9	11.5%	98.7%
Not Satisfactory	1	1.3%	100%
Totals	78	100%	

The next four questions (questions 4-7) addressed peoples' feelings on the Cave projects ability to increase tourism. Responses to all four questions were again very positive. In regards to the environmental safety of the project (see Table 17), a remarkable 93.6% of people feel that the project is definitely (64.1%) or probably (29.5%) environmentally safe.

TABLE 17

RESPONDENTS ANSWERS REGARDING PROJECTS ABILITY TO REMAIN SAFE FOR THE ENVIRONMENT

Will project remain safe for the environment?	Frequency	Percent	Cumulative Percent
Definitely	50	64.1%	64.1%
Probably	23	29.5%	93.6%
Maybe	4	5.1%	98.7%
Doubtful	1	1.3%	100%
No	0	0%	
Totals	78	100%	

Question 6 (see Table 18) identified similar results with 87.2% of people indicating the Cave project will actually result in the improvements of the Caves ecological value (definitely 56.4% and probably 30.8%). Combined, questions 5 and 6 demonstrate that the ecological aspect of sustainability appears to be well developed. Even during a time of construction and development within the Cave, visitors still agree that the end result will be an overall ecological improvement to the Cave environment.

TABLE 18
RESPONDENTS ANSWERS REGARDING PROJECTS ABILITY TO IMPROVE ECOLOGICAL VALUE OF CAVE

Is project going to improve ecological value of Cave?	Frequency	Percent	Cumulative Percent
Definitely	44	56.4%	56.4%
Probably	24	30.8%	87.2%
Maybe	9	11.5%	98.7%
Doubtful	1	1.3%	100%
No	0	0%	
Totals	78	100%	

Although improvements to the overall aesthetical value were not the primary goal of the project inside the Cave, question 7 shows that it is a fortunate result (see Table 19). Again, a very high 92.3% of visitors (definitely 55.1%, and probably 37.2%) agree that work being done inside the Cave will have positive results, in terms of aesthetic value. It is important to note that increases in tourism as a result of aesthetic improvements to the Cave will also bring in the needed funds to continue with the Cave project.

TABLE 19

**RESPONDENTS ANSWERS REGARDING PROJECTS ABILITY TO
IMPROVE AESTHETIC VALUE OF CAVE**

Is project going to improve aesthetic value of Cave?	Frequency	Percent	Cumulative Percent
Definitely	43	55.1%	55.1%
Probably	29	37.2%	92.3%
Maybe	4	5.1%	97.4%
Doubtful	1	1.3%	98.7%
No	1	1.3%	100%
Totals	78	100%	

Most importantly to section D, question 8 addresses the critical topic of whether or not the project will increase tourism. Perhaps the most important question of the questionnaire, a substantial 93.6% of people either definitely (67.9%) or probably (25.9%) agree that the project will in fact increase tourism (see Table 20). Only when tourist numbers to Crystal Cave increase will the ecotourist based management strategy be able to obtain ecological and financial sustainability

TABLE 20

**RESPONDENTS ANSWERS REGARDING PROJECTS ABILITY TO
ATTRACT TOURISM**

Will project increase tourism?	Frequency	Percent	Cumulative Percent
Definitely	53	67.9%	67.9%
Probably	20	25.6%	93.6%
Maybe	3	3.8%	97.4%
Doubtfully	2	2.6%	100%
No	0	0%	
Totals	78	100%	

§.6.1 SECTION D SUMMARY

Most important to the Crystal Cave project is that tourists appreciate the work being done and feel that it is appropriate. Section D of the Cave questionnaire provided the information that reveals they do. With nearly 95% of tourists wanting to hear more about the project, and over 87% finding the tour guides better than satisfactory, environmental awareness and education are being developed in the minds of tourists to the Cave. Given the increase in the tours emphasis on the amphipods, positive feedback has already been evident with over 93% of people agreeing the project is safe for the environment, 87.2% thinking it will improve the ecological value of the Cave, and a astonishing 92.3% feeling it will improve aesthetics. All these figures are compounded into the one important and final question on whether or not tourism will increase. Again, a remarkable 93.6% of visitors feel that tourism will in fact increase as a result of the project. Whether these increases are due to ecological or aesthetical reasons is irrelevant, as increased tourism will not only raise funds available for the project, but also raise the public's awareness though the educative component of the tour. Only then will the ecotourist based management strategy occurring in Crystal Cave both fit the necessary elements of ecotourism, and be considered ecologically and financially sustainable.

Having determined visitors' responses as positive in terms of an ecotourist based management strategy, it is now imperative that the ecological and financial aspects of the Caves pilot project are quantitatively appropriate as well. With the questionnaire responses

positive, the next chapter will look at whether or not the pilot project has in fact maintained sustainability.

CHAPTER 7: ANALYSIS OF ECOLOGICAL AND FINANCIAL SUSTAINABILITY

In order to assess the success of the pilot project occurring within Crystal Cave, quantitative ecological and financial factors of the project must be analysed to ensure that they remain sustainable up to the time of the completion of this study. Unfortunately, as of the point at which this study was in its information gathering stage, the pilot project was not yet completed. However, this chapter of this study will address an analysis of the ecotourist based management strategy's pilot project in progress. Sustainability issues remain relevant throughout the project, therefore, although sustainability results do not include the completion of the project, progress up until the completion of this project may still provide for valid insight in the final outcome.

7.1 ECOLOGICAL SUSTAINABILITY

Evaluation of ecological sustainability within Crystal Cave will be presented first. The primary goal of the pilot project is to sustain a species existence and increase their numbers. Ecological sustainability will be evaluated through,

- a) CALM rangers ability to increase amphipod numbers,
- b) CALM rangers ability to increase groundwater levels within the Pantheon section of Crystal Cave.

Only if results to both issues are regarded as sustainable, will ecological aspects of the pilot project be considered ecologically sustainable.

7.1.1 ABILITY TO INCREASE AMPHIPOD NUMBERS

The ecotourist based management strategy occurring within Crystal Cave is based on the continued survival of the amphipods existence within the Cave. It is for this reason that ecological sustainability will be based on CALM rangers ability to increase the amphipods population and sustain these increased numbers.

In order to analyse progress made in regards to amphipod numbers, we must first look at previous numbers of species counted within the Cave. Unfortunately, when Dr. Brenton Knott first discovered the amphipod species in 1982, no concrete counts of the species were immediately carried out as the species were in no serious threat of extinction. When water levels began receding in the early 1990's, it was Dr. Edyta Jasinska who rescued approximately 15 individual specimens from the Cave (Hillman, 2000, p. 7). These individuals were then introduced into artificial environments (see Plate 5.2) in anticipation that they would reproduce. Artificial tank environments were considered the first main development in the ecotourist based management strategy within Crystal Cave. Occurring concurrently of the species introduction of these tanks, the original pond in the Cave in which the amphipods were discovered was being dug deeper (see Plate 5.3) into the reseeded groundwater in order to ensure some natural habitat remained. Combining the rescued individuals in the tanks, and the amphipods left surviving in the original pond, the lowest estimated number of amphipods to exist since their discovery is believed to have reached approximately 80

individual specimens (as mentioned on tour). More important to note here, is that had it not been for the introduction of the fish tanks and the digging of the initial pond, groundwater levels would have gone below the surface and all amphipods could have easily been lost. Initial steps taken had already insured the survival of approximately 80 amphipods.

Success with the initial steps encouraged CALM rangers to proceed with secondary measures within the Cave aimed at increasing species numbers. The addition of two lined ponds (see Figure 7), each containing a soakwell (see Plate 5.4) allowed for some amphipods to be transferred outside of the fish tanks. These ponds provided test pools for the larger work planned in the Pantheon section of Crystal Cave during the completion of the Caves pilot project.

On February 26th 2000, three male, and three female amphipods were transferred to each of the two lined ponds. After several successful weeks of survival, those numbers were doubled, so that a total of twelve amphipods had been introduced into the artificial environments.

To date, all twelve amphipods in the artificial pools, and all individual amphipods introduced into the fish tanks have survived, and many have reproduced. As of the completion of information gathering on this study (August 1st 2000) CALM rangers estimate that there are over 150 amphipods in Crystal Cave, approximately half being female, many of which are currently carrying egg sacks.

After half a decade of continual habitat depletion, amphipod numbers within Crystal Cave have definitely increased due to work done for the ecotourist based management strategy. With over 150 amphipods

surviving in the artificial environments inside the Cave, many containing egg sacks of offspring, the only question as to amphipod survival remaining is CALM rangers ability to provide artificially rejuvenated groundwater levels within Crystal Cave until the previous environmental conditions recover. Having chosen the Pantheon as an area large enough to provide for increased population, we must now analyse progress made towards its upcoming flooding.

7.2.2 WATER LEVELS

The other ecological aspect that must be examined in regards to sustainability inside Crystal Cave involves the artificial increase of the amphipods environment. With the successful increase of amphipod numbers within the Cave, establishment of increased environment for the amphipods has now become the main concern of the pilot project.

With the pilot project not yet complete, the goal of this thesis is now to analyse ecological sustainability efforts made at increasing water levels to date. Educated predictions as to the pilot projects sustainability until its conclusion can then be drawn from these conclusions.

Initial steps taken outside the Park to return groundwater to its initial levels has included the thinning of pines in the surrounding region (see Figure 5), as well as the initiation of groundwater management in that region (see Plate 5.1). Unfortunately, it is far too early to tell whether or not actions such as these are taking an immediate effect at restoring natural water levels. Conclusions to these questions will not be known for several years. It is for this reason that survival of the amphipod species

within Crystal Cave will only be possible if the amphipods are able to survive in an artificial environment for some time. As the previous section of this chapter mentioned, sustaining life within artificial environment so far has successfully been carried out within Crystal Cave. Now, with the continuation of the pilot project, the much larger Pantheon section of the Cave has been selected for flooding. However, due to the large size of the Pantheon section (see Figure 7), it is obvious that a water source other than the soakwells must be discovered, to supply the Pantheon with water for some time. Only when the appropriate water source is found, and the water successfully used in the Cave can the project remain ecologically sustainable.

In order to develop the pilot project within the Pantheon section, an appropriate water source had to be located within the Park. This water source must suit key physical, chemical and biological parameters, as well as provide a sufficient amount of water to supply Crystal Cave, as well as the existing Park needs.

Such a water source was discovered in YN8 (see Figure 8). YN8 was found to have the acceptable parameters as well as sufficient water to supply existing Park needs (Appendix 2). CALM rangers were also able to develop a system whereby water from YN8 could successfully be transported to the Pantheon section (see Figure 14). For further detail on this system, see the previous chapter outlining the design of the pilot project.

Having been able to sustain amphipod life, and increase amphipod numbers in artificial environments within Crystal Cave, CALM rangers

have developed an ambitious test pilot within Crystal Cave aimed at sustaining amphipod life until water levels return to normal. Given the success of initial ponds, as well as the allocation of the necessary equipment to suit water needs, the Crystal Cave project has every indication of progressing in an ecologically sustainable manner. Concentration must now be placed on whether or not this ecologically sustainable project will fall within financially sustainable parameters for Yanchep National Park.

7.2 FINANCIAL SUSTAINABILITY

With ecological aspects of the pilot project taking place within Crystal Cave remaining sustainable, the attention of this thesis must now focus on the pilot projects ability to proceed in a financially sustainable manner. For this analysis, a breakdown of revenue earned from Crystal Cave in the 1998/1999 fiscal year will be compared to the 1999/2000 Cave revenue in order to determine increased profits gained as a result of raised ticket prices. Only if increased revenue is of equal or greater value to the excess moneys needed to advance with the pilot project will the ecotourist based management strategy be considered financially sustainable. Questionnaire results are also referred to in this section with regards to visitors feelings towards the value of the Cave tour.

All results found in this section will be taken up until the fiscal years ending on the last day of June, 2000. Although ecological data included the month of July, Yanchep National Parks economic structure permits for far more accurate numbers if research is taken from within the fiscal year.

7.2.1 REVENUE

Determining revenue earned as a result of increased ticket prices requires a comparison of the 1998/1999 fiscal year to the 1999/2000 fiscal year. Important to note here is that although CALM and WRC may have aided with financial assistance towards the project, these moneys will not be included as revenue. Only visitors fees will be regarded in order to remain true to the financial element of ecotourism that is present in this studies excepted definition of ecotourism.

Entrance prices for the Crystal Cave tour were raised as the key financial element of this ecotourist based management strategy. With all profits used to benefit the amphipod species, prices for the Cave tour were significantly increased at the beginning of October 2000. At this time, an adult ticket was increased form \$2.00 to \$5.00, and a child ticket from \$0.50 to \$2.00. It was originally feared that this increase in cost would deter tourists from visiting the Cave environment. However, as results to the visitor questionnaire have demonstrated, less than 10% of visitors are currently not pleased with the overall value of the tour (see Table 12), and an astonishing 93.6% of people believe tourism will soon increase(see Table 20). Even with word of mouth advertising having not had a chance to be significantly felt in the Park, an increased \$28,229. 50 was made by Crystal Cave in the 1999/2000 as compared to the 1998/1999 fiscal year. (see Appendix 3). Therefore, if money used to complete the pilot project is equal to or less than \$28,229.50, the ecotourist based management project within Crystal Cave will be considered financially sustainable.

7.2.2 COST

Putting a final price tag on the Crystal Cave pilot project is a difficult task, as the pilot project had not been finished upon the completion of this thesis. As it is the money earned within this fiscal year that will be used to fund the pilot project however, a pricing list has been made with CALM rangers and a hydrobiological expert as to the estimated pricing of the project. With materials priced, and the assurance that labour has been overestimated, this thesis will regard this price list as a true cost analysis for the pilot project. Also important to note is that in this analysis guides and rangers wages are not considered, as they do not generally have a significant year to year effect. Only labour used in the pilot project required beyond normal Park allowance will be considered in this analysis. Also excluded from this analysis is previous works done within the Cave towards the amphipod species. These works have already been financed through profits made within Crystal Cave. All work done within the Cave to date has been financed from tour profits.

Without regular Park staff's wages included, the price list for the Crystal Cave pilot project in the Pantheon section has a grand total of \$8,151.50 (see Table 21).

TABLE 21

**COSTING FOR CRYSTAL CAVE WATER SUPPLEMENTATION: TEST
AREA (PANTHEON SECTION)**

PRICING LIST	COST
Main Valve Adjustment: Requires a T-junction inserted and a converter from 5in PVC piping to 2in polly.	\$150
Three rolls of 100m 2in polly tubing	\$750
Two 2in Shut off bore valves	\$80
Three 2in 90° angles	\$30
223 sq. meters of Maxipool pond liner	\$1226.50
Recirculation pump and piping	\$250
Two soakwells	\$30
Cost for Non-lined test Labour	\$1205+ <u>\$1000</u>
Total	\$2205
Cost for lined plus recirculation test Labour	\$2430+ <u>\$1000</u>
Total	\$3430
Grand Total	\$8151.50

Source: Personal Files of Paul Tholen, ranger in charge of Cave project

With the Parks ability to sustain high tourist numbers, even with increasing ticket prices, Crystal Cave has been able to sustain an \$28,229.50 profit higher than the previous fiscal year (see Appendix 3). This increase is bound to continue as tourism is expected to increase. Also positive, the full effects of raised ticket prices havenot been

measured as the fiscal year began in July, three months before prices were increased. However, as the pilot project is being funded by the profits made within the current fiscal year, excess prices (above regular Park fees) towards the project must mainly fall within the profit range. Successfully done, the total price tag for the pilot project is estimated at costing an incredible \$20, 078 less than the available money at \$8,151.50. Being in the developmental, and therefore most expensive stage of the project, and with increases in word of mouth advertising evident, this thesis has determined that the pilot project within Crystal Cave is progressing in a financially sustainable manner. Increased tourist income via higher ticket prices appears to have the ability to pay for the Cave project, without the aid of government funding until such time that groundwater levels are returned to the local region.

7.3 SUMMARY

Quantitative aspects to the ecotourist based management strategy within Crystal Cave include both ecological and financial aspect of the pilot project. Only if both aspects of the project were found to fall within sustainable limits would the project be considered sustainable for this thesis.

Ecologically, the pilot project was very successful. With the increase to both amphipod numbers, and the ability to sustain them within artificial environments, CALM rangers have hopefully insured the survival of these amphipod species until regional groundwater levels return. Financially, the pilot project also appears to be sustainable. Increased

ticket prices, combined with sustained tourist numbers have more than paid for moneys used towards the Cave project (above normal Park fees). With the pilot project in its final phases upon the writing of this thesis, and all signs of success eminent, it is the final analysis of this study that the pilot project occurring within Crystal Cave is in fact quantitatively sustainable.

8.1 DISCUSSION

This study was aimed at exploring the success of an ecotourist based management strategy. It was hypothesised that a properly managed ecotourism based development would provide the funds needed to ensure ecological and financial sustainability within an environmentally sensitive area. It was also expected that the necessary expansion in revenue would occur as a result of increased word of mouth advertising and repeat visitation, generated as a result of the ecotourist project.

The ecotourist based management strategy took place in Crystal Cave in Yanchep National Park, located only kilometres north of the city of Perth, Western Australia. This study examined a pilot project within the Cave which was conducted to increase the numbers of an endangered amphipod species while simultaneously working to increase the depleting groundwater levels of that Cave necessary to support the amphipods development. All work for this project has been subsidised by tourist income brought to the Cave by raised entrance fees for the Cave tour. Future increases in revenue through increased tourist numbers are also expected to occur when word of mouth advertising about the project encourages environmental awareness within the Cave.

Two studies were conducted to determine the success of the ecotourist based management strategy. The first of these studies was a qualitative questionnaire to determine the visitor profile to the Cave tour, visitors attitudes about the tour, visitors response to the entrance fees for

the tour, as well as the level of appreciation for the project visitors gain from the tour. The second study is a quantitative analysis of the ecological and financial aspects of the pilot project. The purpose of this second study was to determine the success of maintaining sustainability throughout the duration of the project.

Two populations were targeted throughout this study. In the first qualitative study, ecotourists were the target population. Assessment of the questionnaires was aimed at determining whether or not visitors gained an appreciation for the project, and if so, would this help increase future tourism through word of mouth advertising and repeat visitation. The second target population was the amphipod species found within Crystal Caves groundwater. The amphipod species was targeted through quantitative investigations of the projects ecological and financial sustainability. The aims of this study were to determine if amphipod numbers had in fact increased as a result of the project, and, had the project been able to fund itself through the profits made by increased ticket prices. In order to be successful, the ecotourist based strategy had to show that appreciation gained by visitors was enough to increase tourism to a point that the increased profits could sustain the amphipod life until groundwater levels within the Cave return to normal.

A national park environment was the site for this study. With the second national park in the world (Royal National Park), Australia has a long and rich history in environmental protection through the national parks services. One of the first parks in Western Australia, Yanchep was an appropriate place to conduct research on ecotourism. Park

development has been based on a history of 'dedication for public enjoyment and inspiration' and 'protection from all interference other than essential management practices. An Australia national park makes the ideal environment for an ecotourist based management strategy. It is for this reason that CALM and WRC chose ecotourism as an essential management practice to be used within Crystal Cave to save the endangered amphipod species.

Developed in the 1980's, ecotourism is a geographical catch phrase adopted from *Our Common Future*, a book published by the WCED (1987). Ecotourism has become one of the most influential concepts in the tourism industry. However, it is interesting that no single definition of ecotourism has become internationally accepted definition. For purpose of clarity in this study the EAA's definition will be used. Specifically this states that ecotourism includes "ecologically sustainable tourism that fosters environmental and cultural understanding, appreciation and conservation" (CDOT, 1994, p. 3). Within this definition, five elements are required.

1. a nature element
2. an ecologically and culturally sustainable element
3. an educative and interpretive element
4. an element based on regional and local benefits, and
5. a financial element

Combined, these five elements allow for a project that is completely sustainable.

The pilot project within Crystal Cave contains all five elements and is considered a true ecotourist based management strategy. The pilot project first involved work outside the Cave with intermediate measures aimed at restoring groundwater levels. These measures included the thinning of pine plantations as well as the introduction of regional groundwater abstraction restrictions. Having completed this, work within the Cave began, adding a number of artificial environments aimed at ensuring the amphipod species survival. With this successfully carried out, the preparation of a large section of the Cave to be flooded, including a dramatic and expensive water supply system to supply water from an outside source commenced. The Crystal Cave project will need to continue to supply water to this section of the Cave and remain self funded until the time that regional groundwater returns to a level satisfactory to amphipod survival. This may not occur for a number of years.

The following findings come from the questionnaire analysis, as well as ecological and financial information gathered from within the Cave. Although this project was not complete at the time of this study, findings are based on the best and most available knowledge.

8.2 FINDINGS

The next section in this concluding chapter is the general findings of the two studies conducted in this research; the questionnaire analysis and the quantitative ecological and financial analysis.

8.2.1 QUESTIONNAIRE ANALYSIS

The questionnaire used within this research had four sections (sections A-D). Section A of the questionnaire identified a demographic visitor profile: Section B examined visitors attitudes about the tour. Section C focused on the value of the Cave tour, and Section D examined attitudes about the project itself.

Section A of the questionnaire demonstrated clearly that Crystal Cave attracts mainly local families crowd. Yanchep's family orientation reflects the proximity of the Cave to Perth. This section also revealed that few visitors take the Crystal Cave tour because of word of mouth advertising. Since one of the key aspects to any ecotourism project is word of mouth advertising, this finding draws concern.

Section B of the visitor questionnaire demonstrated that visitors attitudes about the Cave tour are very positive. Over 90% of visitors were willing to recommend the tour to potential visitors and 0% rate the tour negatively. With over 90% willing to recommend the tour, it is expected that word of mouth advertising should positively influence future tourism and subsequently ongoing funding for the project.

Section C showed that a very positive 91% of respondents were pleased with the value of the tour. In addition, over 92% of respondents felt that the project was worth the investment. Given the potential for future tourism as a result of word of mouth advertising and a clear support for continued investment in the project, the Cave project would appear to have a financially sustainable future.

Finally, section D of the questionnaire clearly identified that participants in the tour do in fact appreciate the work occurring within Crystal Cave. Nearly 95% of tourists wanted more information on the project. Respondents feel agree that the project is safe for the environment (93%), that it will improve the ecological value of the Cave (87.2%), will improve the aesthetical value of the Cave (92.3%), and finally, will lead to increased tourism (93.6%). From these figures, a very positive appreciation from visitors towards the Cave project was established.

With such positive results stemming from the questionnaire analysis, quantitative findings on the ecological and financial aspects of the project were then gathered.

8.2.2 ECOLOGICAL FINDINGS

Ecologically, amphipod numbers within Crystal Cave have most definitely increased due to work done within Crystal Cave. As of the completion of information gathering on this study, CALM rangers estimate that there are over 150 amphipods within Crystal Cave including many females, some of which are carrying carrying eggsacks. Only a few short years ago this number is believed to have been as low as 80, and had it not been for CALM rangers work within the Cave, amphipod numbers could have easily dropped to 0 as the groundwater went below the surface, rendering them extinct.

The ecotourist based management strategy in Crystal Cave has successfully saved an endangered species through the introduction of artificial environments within Crystal Cave.

Financially, the ecotourist based management strategy is also extremely successful. Revenue from increased ticket prices combined with continued high visitation to the Cave has added an additional \$28,229.50 to Park income. The pilot project on the other hand, only requires \$8,151.50 to be completed. The pilot project occurring in Crystal Cave will be able to sustain itself financially for many years without the aid of loans or grants, and is therefore considered financially sustainable.

The ecotourist based management strategy has resulted in ecologically and financially sustainable. Together, the questionnaire analysis and quantitative study demonstrate a successful example of a sustainably developed ecotourist based management strategy.

8.3 CONCLUSIONS

Crystal Cave provides an excellent case study in which an ecotourist based management strategy has been able to increase local appreciation for the environment while saving an endangered species from extinction. A number of sociological, ecological and financial conclusions can be drawn from this study.

Socially, this study shows that when ecotourist based projects expose the public to environmental concerns, awareness is increased and appreciation for that environment develops. A substantial number of visitors participated as tour visitors or attracted by nature (66.6%). Clearly

Crystal Cave is an attraction for environmentally conscience tourists. It is concluded from this study that the changing emphasis of the Cave tour to one based on environmental concerns has heightened peoples' interest in the future of the Cave. This study further supports an increase in tourism in the future which is related to these environmental interests. In fact, 94.9% of visitors believed that insufficient information on the project was given. Also 96.3% are willing to either definitely or probably recommend the tour to others. This will not only raise public awareness to regional environmental problems, but it will also help raise tourist numbers within the Cave.

The future increase in tourist numbers leads to the second conclusion of this paper. Ecotourist based projects such as the one in Crystal Cave are able to create enough appreciation for themselves to ultimately become self funded. In the Crystal Cave example, raised ticket prices to the Cave resulted in a \$28,229.50 increase in profit. However, only \$8,151.50 is required to finish the pilot project. Requiring less then one third of the revenue, Crystal Caves project is clearly adequately funded. However, to artificially retain the amphipod life for several years, the ecotourist based management strategy must continue ongoing financial support. Results of this study support this possibility. In this regard, 67.9% of respondents stated they would return to the Cave if in Yanchep in the future, and 92.3% would either definitely or probably recommend the tour to others. It is important to note that 91% of respondents were pleased with the value of the tour, and 92.3% of respondents were positive about the value of the project and the

investment of funds to support the work. In fact, 93.6% of people believe tourism will increase as the project progresses. Given such overwhelming support plus the financial surplus from current revenue, it is concluded that ecotourist based projects such as Crystal Cave can remain financially sustainable.

In ecotourism, increased tourist numbers and financial sustainability permits a third conclusion on ecological sustainability. That is that ecotourist based developments such as the one in Crystal Cave can remain ecologically sustainable with funds earned from increased tourism. Qualitatively, 93.6% of visitors believe work is definitely or probably safe for the environment, 87.2% believe it will definitely/probably improve the ecological value of the Cave, and 92.3% believing it will improve aesthetic values. All this will encourage word of mouth advertising and repeat visitation. However, none of this is important if the ecological values are lost. In the Crystal Cave example, excess profit from increased tourism was able to fund an aggressive pilot project within the Cave environment. Quantitatively, it is this project which has brought the amphipod species from approximately 80 individuals in existence to the current number 150, including many females with eggsacks. Had it not been for the Crystal Cave project, that number could have easily dwindled to 0, and the subsequent extinction of the amphipods as their groundwater environment sunk below the Cave floor. The third conclusion of this study is therefore, that ecotourist based developments can remain ecologically sustainable as a result of increased tourism.

Taken together, the pilot project occurring within Crystal Cave produces a final, all encompassing conclusion that properly managed ecotourist based developments can ensure ecological sustainability through funds raised by increased tourist exposure to an environmentally sensitive area.

8.4 RECOMMENDATIONS FOR FURTHER RESEARCH

There are a number of directions ecotourism research needs to follow in order to become a true element of sustainable development. Questions still exist regarding the proper definition of ecotourism and how to rate ecotourism developments. Sufficient case studies need to be gathered to develop a theoretical framework for ecotourism.

Developed as recently as the early 1980's, one of the main problems for research in ecotourism is its definition. With no completely accepted definition of ecotourism, businesses and governments have often developed their own definitions. Many of these definitions, unfortunately lack the needed boundaries to ensure that tourist developments remain sustainable. Work needs to be done in developing an internationally accepted definition of ecotourism that will ensure sustainability within large tourist projects. This definition, although specific in goal, will need to be able to adapt to different socioeconomic and environmental conditions as the situation requires.

Along with the idea of definition, it is also the prospect of this research that an internationally accepted checklist be developed in order to 'rate' ecotourist developments around the world. Although many

ecotourist groups try to do this, work is still in the beginning stages and problems arise with regards to the definition of ecotourism being used. Further research in this area needs to be aimed at ensuring sustainability, and 'analysing different sustainable aspects of each project. Another aspect of future research would address the perception and attitude towards ecotourism at different global sites. Not only would this permit a better understanding of ecotourism as a global phenomenon but would allow vacationers more informed decisions in choosing ecotourist vacations. Such an approach would also promote global attention to ecotourist developments. This could lead to an internationally recognised checklist for ecotourism based developments. The framework for this checklist could begin by recognising successful ecotourist based projects such as the one in Crystal Cave. Further, case studies should be included that have likewise demonstrated support for ecotourist development. Crystal Cave for example shows how an ecotourist based development was able to develop local appreciation enough to increase tourism and raise the funds needed to remain financially, and therefore ecologically sustainable. It is the premise of this study that if enough case studies were produced to deal with any multitude of environmental problems, then an eventual framework could be constructed as guidelines for ecotourist developments. This framework could provide the blueprint on which ecotourism could be judged. Once such a framework existed, it would include the parameters to develop the checklist to assess ecotourism.

Ecotourism is quickly becoming one of the most popular and important aspects of tourist development in the world today. However,

many developments remain unsustainable, defeating the original purpose of ecotourism. By further developing examples of successful ecotourist based developments such as the one occurring in Crystal Cave, an eventual definition, guidelines for development and assessment can be developed. This study supports a positive future for ecotourist developments.

APPENDIX 1 CRYSTAL CAVE VISITOR QUESTIONNAIRE



EDITH COWAN
UNIVERSITY
PERTH WESTERN AUSTRALIA

Yanchep Crystal Cave Survey

This survey is part of a study in ecotourism. I am a fourth year honours student at Edith Cowan University and my particular interest is in the area of *ecotourist based developments that ensure ecological sustainability*. In simple terms. The aim of this survey is to gather information that will be used to determine the ecological and financial sustainability of the groundwater regeneration project which is currently taking place within Crystal Cave, Yanchep.

Participation in this study is entirely voluntary. If you do choose to participate, the information will be treated confidentially and your anonymity is guaranteed. The survey contains the following sections and should only take a few minutes of your time:

- Section A – Background Information
- Section B – General Feelings about Crystal Cave Tour
- Section C – Feelings about Entrance Fee to Crystal Cave
- Section D – Feelings about Crystal Cave Project

Contact Details

Charles Priddle © May 2000

Edith Cowan University

Ph: (08) 9204 2264

Email: cpriddle@hotmail.com

Section A Background Information

1. Where is your current residence?

- 1 ☐ Yanchep / Waneroo
- 2 ☐ Perth
- 3 ☐ Elsewhere in Western Australia
- 5 ☐ Elsewhere in Australia
- 6 ☐ Outside Australia

2. What is your current age?

Under 20 ☐ 21-30 ☐ 31-40 ☐ 41-60 ☐ Over 60 ☐

3. What was your main motivation for visiting Yanchep National Park today?

- 1 ☐ Caves
- 2 ☐ Wildlife
- 3 ☐ Picnic / BBQ
- 4 ☐ Lodge or Museum
- 5 ☐ Golf course / Recreation
- 6 ☐ Other

4. What was your main motivation for visiting Crystal Cave?

- 1 ☐ It is on the tour
- 2 ☐ Interest in nature
- 3 ☐ Heard good things from others
- 4 ☐ Had enjoyed it previously
- 5 ☐ Heard of project being done inside
- 6 ☐ Other

5. Is this your first visit to Crystal Cave?

Yes ☐ No ☐ I have not been in over 20 years ☐

Section B General Feelings about Crystal Cave Tour

		Definitely	Probably	Maybe	Doubtful	No
1	Would you visit Crystal Cave if in Yanchep again	1	2	3	4	5
2	If in Perth area, would you return to Yanchep in order to see Crystal Cave again	1	2	3	4	5
3	Would you recommend the Crystal Cave tour to someone you knew was visiting Yanchep National Park	1	2	3	4	5

4. Overall how would you rate your visit to Crystal Cave?

Excellent ☐ Good ☐ Average ☐ Bad ☐ Terrible ☐

Section C Feelings about Entrance Fee to Crystal Cave
--

1. Do you believe the Crystal Cave tour is worth the price of admission?

- 1 ☐ I was surprised with what I got for the price
 2 ☐ I was pleased with what I got for the price
 3 ☐ I was disappointed with what I got for the price
 4 ☐ I am displeased with what I got for the price

2. Do you believe that the work being done within Crystal Cave should be paid for by incoming tourist dollars (as opposed to government grants)?

Definitely ☐ Probably ☐ Maybe ☐ No ☐

3. Overall, do you feel that the work being done within Crystal Cave is worth the money being put into it?

Definitely ☐ Probably ☐ Maybe ☐ No ☐

Section D
Feelings about Crystal Cave Project

1. What had you heard about the species and/or project to restore the water levels in Crystal Cave?

Quite a lot ☐ A little ☐ Something ☐ Nothing ☐

2. Do you feel that enough information is provided about the species and project to restore the water levels in Crystal Cave?

- 1 ☐ I would like to have heard a lot more about the species and / or project
 2 ☐ A little more information would have been appreciated
 3 ☐ A little too much emphasis was put on the project / species
 4 ☐ Far too much of the tours emphasis was on the project / species

3. How would you rate the tour guides manner in being helpful and knowledgeable with regards to the project and the species within Crystal Cave?

Excellent ☐ Good ☐ Satisfactory ☐ Not Satisfactory ☐ Poor ☐

Please indicate what your opinion is on the following four issues by circling the option of your choice.

	Definitely	Probably	Maybe	Doubtful	No
4. Is the Crystal Cave project safe for the environment	1	2	3	4	5
5. Is this project going to improve Crystal Caves ecological value	1	2	3	4	5
6. Is the work being done within Crystal Cave going improve its aesthetic value	1	2	3	4	5
7. Will the work within Crystal Cave attract tourism by rejuvenating water levels and / or saving the species	1	2	3	4	5

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY

APPENDIX 2

VOLUMES OF WATER REQUIRED TO FILL CRYSTAL CAVE TO A HEIGHT OF 5 CM UNDER VARIOUS POSSIBLE WATER CONDITIONS

SECTION

1. JEWEL CITY
2. NEAR ELEPHANTS FEET
3. NEXT TO TUNNEL
4. WISHING WELL
5. PANTHEON
6. ORIGINAL POND

FILL TIME REFERS TO TIME TAKEN TO FILL POND HIEGHT OF 5CM

2(a) RESULTS OBTAINED USING HYDROLIC CONDUCTIVITY AND
DEPTH TO WATER TABLE AS INDICATED AT EACH LOCATION

SECTION	AREA (sgm)	HYDROLIC CONDITION	DISCHARGE	WATER TABLE	RESULTS: FILL TIME AND AMOUNTS
1.	62	1	100	0.53	46 min. // 3000L/day
2.	46	2	100	0.695	34 min. // 4600L/day
3.	56	4	100	0.635	43min. // 11200L/day
4.	26	5	100	0.58	20 min. // 6500L/day
5.	223	6	100	0.78	4.45 hrs. // 66900L/day
6.	35	8	100	0.66	28 min. // 14000L/day
TOTAL	448		100		6.53 hrs. // 106200L/day

Results: If the data was 100% accurate, then this data could be used at face value. As the data was obtained under relatively experimental means, an average would be more acceptable

**2 (b) RESULTS OBTAINED USING AN AVERAGE OF THE WATER
DEPTH AND HYDROLIC CONDUCTIVITY**

SECTION	AREA (sqm)	HYDROLIC CONDITION	DISCHARGE	WATER TABLE	RESULTS: FILL TIME AND AMOUNTS
1.	62	5	100	0.8	49 min. // 15500L/day
2.	46	5	100	0.8	36 min. // 11500L/day
3.	56	5	100	0.8	44min. // 1400L/day
4.	26	5	100	0.8	20 min. // 6500L/day
5.	223	5	100	0.8	3.93 hrs. // 55750L/day
6.	35	5	100	0.8	27 min. // 8750L/day
TOTAL	448		100		6.63 hrs. // 112000L/day

Results: These results will probably be closest to what is expected

**2 (c) RESULTS OBTAINED USING A WORST CASE SCENARIO WITH
MAXIMUM WATER TABLE AND MAXIMUM HYDROLIC
CONDUCTIVITY**

SECTION	AREA (sqm)	HYDROLIC CONDITION	DISCHARGE	WATER TABLE	RESULTS: FILL TIME AND AMOUNTS
1.	62	5	150	0.895	33 min. // 24800L/day
2.	46	5	150	0.895	24 min. // 18400L/day
3.	56	5	150	0.895	30 min. // 22400L/day
4.	26	5	150	0.895	13 min. // 10400L/day
5.	223	5	150	0.895	2.73 hrs. // 89200L/day
6.	35	5	150	0.895	18 min. // 14000L/day
TOTAL	448		150		6.93 hrs. // 179200L/day

Results: This is the worst case scenario that will be faced. Note that it is within the capacity of the Lakeside bore to still supply these volumes, but a backup system would be of great importance.

Source for Appendix 2 (a, b & c): Personal files of Paul Tholen, head ranger in charge of Crystal Cave water supplementation project

APPENDIX 3

CAVE VISITATION REVENUE (1998/99 VS 1999/2000)

3 (a) FISCAL YEAR OF 1995/96

DATE	ADULT	CHILD	FAMILY	TOTAL
JULY 98	1679	791	0	
AUGUST 98	1664	627	0	
SEPTEMBER 98	1730	568	0	
OCTOBER 98	1883	659	0	
NOVEMBER 98	1778	706	0	
DECEMBER 98	2577	957	0	
JANUARY 99	2490	1118	0	
FEBRUARY 99	1418	322	0	
MARCH 99	1576	407	0	
APRIL 99	2279	94	0	
MAY 99	1091	322	0	
JUNE 99	1273	434	0	
TOTAL (#)	21438	7815		
X'S \$	\$2.00	0.50		
TOTAL (\$)	\$42484	\$3905.50	0	\$46389.50

3 (b) FISCAL YEAR OF 1999/2000

DATE	ADULT	CHILD	FAMILY	TOTAL REVENUE
JULY 99	1590	704	0	
AUGUST 99	1220	444	0	
SEPTEMBER 99	1333	374	49	
OCTOBER 99	847	137	137	
NOVEMBER 99	734	53	106	
DECEMBER 99	951	83	180	
JANUARY 00	1094	212	266	
FEBRUARY 00	820	57	78	
MARCH 00	921	96	114	
APRIL 00	1115	204	243	
MAY 00	599	46	113	
JUNE 00	559	60	122	
TOTAL (#)	11783	2470	1408	
X'S \$	\$5.00	\$2.00	\$8.00	
TOTAL (\$)	\$58515	\$4840	\$11264	\$74619

Note: GST is not included in price increases as profits from tax are not retained by Park.

Source: Adapted from the personal files of Rod Hillman, Park Manager

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