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Jesse Budel

Elder Conservatorium of Music, University of Adelaide

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Abstract

Over the past half century, there has been much research into the acoustic qualities of soundscapes from a variety of perspectives: the humanities and social sciences as per the 'acoustic ecology' movement (established by Schafer, Truax, and Westerkamp et al.), and more recently the environmental science and ecology as per 'soundscape ecology' (established by Farina, Pijanowski, and Krause, et al.). Collectively, these disciplines provide diverse methods for engagement with analysis of acoustic environments. Simultaneous to the rise of the acoustic ecology movement in the 1970s (marked by the publication of Schafer's 'The Tuning of the World' (1974)), the composition of numerous seminal 'minimalist' musical works occurred, notable amongst them Steve Reich's 'Music For 18 Musicians' (1974-6). Whilst there has been significant analysis of this work from a traditional musicological standpoint, the environmental implications of its process-driven nature have gone largely ignored, particularly in relation to ecological processes and behaviours. This paper provides an ecomusicological analysis of 'Music for 18 Musicians', investigating the numerous affinities that the piece has with acoustic ecology and soundscape ecology concepts alike. This will be explored at both a macromorphological level (considering large-scale temporal cycles and processes), and micromorphological level (as related to orchestration, textural organisation, instrumental content in the context of bioacoustics, community sound cues and ensemble agency). A concluding discussion of Reich's compositional influences (themselves influenced by natural soundscapes) and process follows, with questions raised around the possibility of ecomusicological analysis of other 'abstract' musical works to encourage further research in compositional approaches and music therapy.

Steve Reich's '*Music For 18 Musicians*' as a Soundscape Composition

Jesse Budel

Introduction

Steve Reich's '*Music for 18 Musicians*' (hereafter referred to in the abbreviated form, *MF18M*), composed between 1974-76, is widely recognised as a seminal work of minimalist music. Written for a large chamber ensemble comprising of pianos, marimbas and vibraphones, violin, cello, Bb and bass clarinets, and voices, the hour-long work surveys an intricate expanse of harmonic and textural environments by means of multiple algorithmic processes. This accords closely with Reich's process-driven philosophy of minimalist music, articulated in his essay, '*Music As A Gradual Process*' (1968):

“The distinctive thing about musical processes is that they determine all the note-to-note (sound-to-sound) details and the overall form simultaneously... I am interested in perceptible processes. I want to be able to hear the processes happening throughout the sounding music.” (Reich, 2000b, pp. 34-36)

Contemporaneously, Canadian composer and educator R. Murray Schafer developed numerous resources aimed at investigating the qualities and experiences of environmental soundscapes, culminating in the influential '*The Tuning of the World*' (1974, later republished as '*The Soundscape*' (1993)). This work would provide the philosophical underpinning of the 'acoustic ecology' movement, a primarily humanities and social sciences discipline observing and evaluating the various qualities and characteristics of natural and urban soundscapes. This is done in the interest of improving the fidelity (and thus signification) and functionality of a soundscape, which would in turn positively impact on a (human) listener's subjective experience of an acoustic environment.

More recently, this field of study has diversified into the scientific domain through the fields of 'soundscape ecology' and 'ecoacoustics' (Farina & Gage, 2017; Pijanowski, Farina, Gage, Dumyahn, & Krause, 2011; Pijanowski, Villanueva-Rivera, et al., 2011). These disciplines, by contrast to acoustic ecology, observe the soundscape with an understanding of sound as a proxy or representation of ecological activities and processes. Such analyses focus on the interactions between various sound sources, namely biophony (sounds produced by living organisms), geophony (sounds produced by abiotic environmental

processes) and anthropophony (sounds produced by human technological and industrial activities).¹ Additionally, the behaviours of various acoustic parameters are investigated to determine processes in an ecosystem, including frequency patterns (especially through bioacoustics hypotheses, which attempt to explain the ways that animals have organised their collective vocalisations), micro- through macromorphological temporal cycles (diurnal, seasonal and climatic), spatial diffusion and gradients, and amplitudinal (dynamic) variations (Farina, 2014).

Whilst generally deemed an abstract musical work (and not generally a soundscape composition in that it does not represent or draw from a specific environment), further investigation of *MF18M* reveals many affinities between the process-driven musical soundscape and the ecological processes demonstrated in natural and urban soundscapes. This paper will thus consider *MF18M* as a *prospective* soundscape composition, critically analysing the macro- and micromorphological details of the work with reference to both acoustic ecology and soundscape ecology principles and concepts. A concluding section discusses the impact that Reich's engagement with world musics (known for their integral connection to local environments) had on the work, and considers the value of similar ecomusicological analyses on other abstract musical works for further research into compositional approaches and directions for music therapy.

Macromorphology

MF18M is a large-scale modular composition (Potter, 2000, pp. 231-245; Reich, 2000a), typically lasting between 50-70 minutes in duration (depending on performance tempi). The work is divided into 14 distinct sections (Tab. 1): 'Phases', the name of both the introductory and conclusive sections that are comprised of 11 foundational chords (Fig. 1); and 12 intermediate sections that sequentially explore the sonorities of each chord (the third chord undergoing two treatments, 'Section 3A and 3B).

Phases (Intro)	Section I	Section II	Section III A	Section III B	Section IV	Section V	Section VI	Section VII	Section VIII	Section IX	Section X	Section XI	Phases (Conc.)
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Table 1: The formal structure of Music for 18 Musicians.

1 The term 'anthropophony' is has been used here as the most current term for human technologically-based sound activity, rather than the previously used 'anthrophony', which has been recognised as incorrectly using the prefix, 'anthro-' (referring to caves) (Krause, 2015, pp. 153-154).

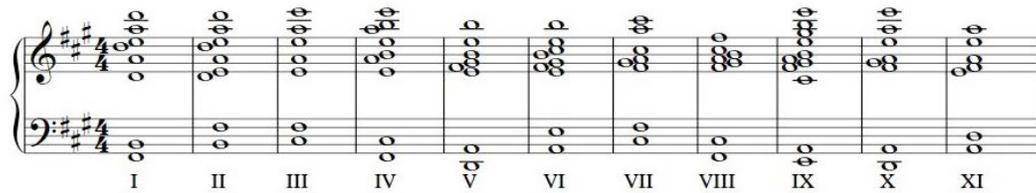


Fig. 1: The 11 foundational chords of Music for 18 Musicians.

The extended duration and cyclical structure of the work lends itself to comparison with environmental soundscape cycles. Operating at various temporal scales (diurnal, seasonal and climatic), both natural and urban soundscapes demonstrate changes in activity correlating with particular times in the relevant cycle. Dawn and dusk choruses, for example, are recognised as distinct periods of a diurnal cycle, displaying the acoustic diversity of a soundscape through heightened animal vocalising at those times (Farina, 2014, p. 8).

The 'Phases' sections of *MF18M* bear similarity to these choruses. They provide a temporal reference point to which other sonic activities relate. In a soundscape, these would be the junctures between night and day; in *MF18M*, these are the terminal points of the work, which might also operate as fulcrums for an infinite cycle. Additionally, the exposition of the 11 foundational chords within 'Phases', providing the piece's genetic basis, gives an overview of the overall content of the work, to be expounded upon in each of the successive sections. Comparatively, the soundscape dawn and dusk choruses provide a similar comprehensive snapshot, featuring a substantial variety of the biophonic contributors who otherwise vocalise intermittently throughout a day/night cycle.

So too the body of the work (Sections I-XI) operates akin to environmental temporal cycles. Gradual changes in the biophony, geophony and anthropophony indicate shifts in ecological activities, resulting in a soundscape's transition over the course of a specified temporal cycle. Likewise, *MF18M*'s iterative progression through the harmonic scheme gradually transitions over the course of the hour's performance (each section typically lasting between 3 ½ to 7 minutes), cohesively connected by a generally static tonal centre (beginning with three sharps, increasing to four sharps at various times later in the work) and multiple common chord tones between successive chords.

Micromorphology

In the same way that *MF18M*'s macromorphology connects with the structures of real-world acoustic environments, *MF18M*'s micromorphological details bear similarity to numerous soundscape phenomena.

The work's ensemble comprises four pianos, three marimbas, two xylophones, a vibraphone, maracas, two clarinets (doubling bass clarinet), violin, cello and four high voices.² Each instrument provides a distinct timbral quality in its own right (due to individual craftsmanship), whilst also complementing their larger instrumental families of percussion, woodwinds, strings and voices through common instrumental structures and/or performance techniques. This bears resemblance to the relationship between individual contributors and the wider biodiversity of an ecosystem and resultant soundscape. Each organism produces sound that is timbrally unique with respect to its individual physiology, whilst simultaneously complementing the vocalisations of conspecifics (members of the same species), and larger biological families and classes (whether mammalian, avian, amphibian or insectile, and so on). This results in complex bioacoustic interrelations between acoustic communities of individuals and species in a soundscape (Farina, 2014, pp. 43-101; Malavasi, Kull, & Farina, 2014).

With such diversity in the ensemble's timbral characteristics, Reich's sensitive orchestration for *MF18M* conveys a variety of bioacoustic behaviours exhibited in natural soundscapes. The Acoustic Niche Hypothesis (ANH) proposes that organisms have evolutionarily organised their vocalisations to specifically tuned frequency and temporal niches (as seen in Fig. 2), so as to avoid acoustic conflict with other species (masking of one another's calls) and consequently maximise communicational efficacy (Krause, 1993). Likewise, *MF18M* displays an organisation of textures that warrants comparison to the ANH. The spacing of the 11 foundational chords provides a rich harmonic framework that occupies a wide bandwidth of the audible frequency spectra. Throughout the entire work, chordal tones are assigned to various instruments on the basis of their most effective registral qualities: bass clarinets and cello often providing pulsating bass drones in their resonant low ranges; middle range contrapuntal activity covered by violin, vocalists, clarinets, percussion and pianos, and the constant high range pulsating drones generally confined to keyboards (due to their available range and idiomatic capacity for sustained activity). Through having the harmonic material separated into particular registers, each sounded with distinctly identifiable timbres (a basic recommendation of orchestration technique (Adler, 2002),³ one is able to clearly and precisely recognise the various instruments at play in the often dense contrapuntal textures (as per psychophysical auditory scene analysis (Bregman, 1990), and demonstrated in Fig. 3), finding

2 Whilst the work nominally calls for 18 musicians, such a number requires doubling on a variety of parts (down from the original 21 musicians called for in the work's development) (Reich 2000).

3 It should not be assumed, however, that human musical practices are necessarily correlated with natural soundscape behaviours or structures, as implied by Krause in his linking the ANH with compositional and orchestration techniques (1993, 2012). There are multiple criticisms of this perspective (see Benítez-Bribiesca, Gray, Payne, Krause, & Tramo, 2001; Skeoch, 2016).

parallel in the explanation of environmental soundscape composition and related communicational strategies proposed by the ANH.

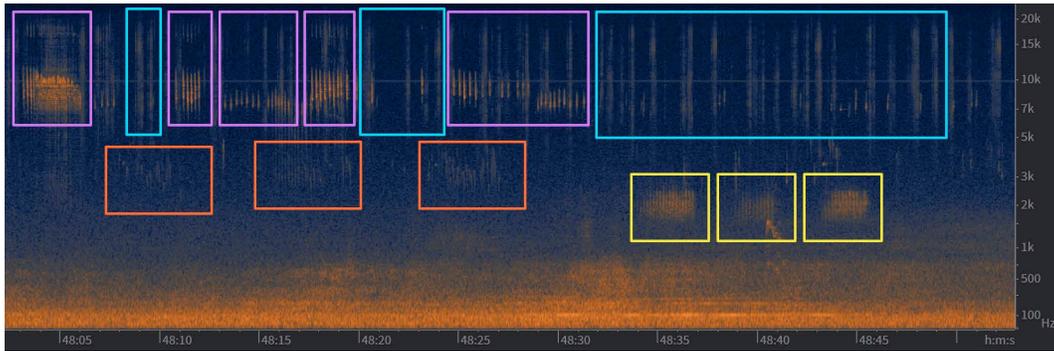


Fig. 2: Distinct bird calls exemplifying frequency and temporal niches as seen in a spectrogram representation of a dawn chorus. Note that the blue and purple identified calls intersperse in the 5kHz-20kHz range (recorded 24 September 2017 in the Organ Mountains, Las Cruces, New Mexico)



Fig. 3: Example from Section I, bb. 109-12, with distinct distribution of frequency and temporal content.

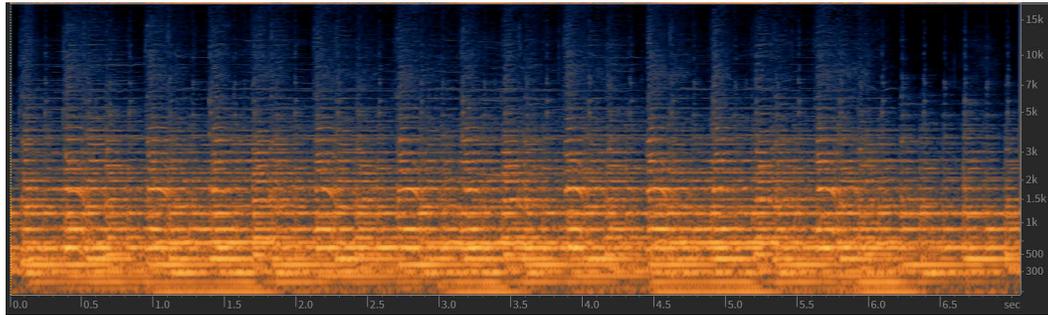


Fig 4: Spectrogram example of excerpt from Fig. 3. Note the partitioning of distinct frequency bands and temporal patterns.

This relates to the acoustic ecology concept of hi-fi and lo-fi soundscapes (Truax, 1999). Drawing on electronic music terminology, a hi-fi soundscape is one with a high signal-to-noise ratio, where all sounds in a soundscape may be clearly heard, free of interference. By comparison, a lo-fi soundscape is one with a low signal-to-noise ratio, where it is difficult to perceive discrete elements of the soundscape due to significant background noise and interference. Through embracing frequency and temporal partitioning, combined with specific timbral distribution of material, Reich has composed what is essentially a hi-fi soundscape experience in a chamber ensemble setting.

Connections between the intricate melodic material found in Sections I-XI and bioacoustic calling behaviours are also found in the form of distinctive rhythmic patterns, additive procedures and canonic imitation. Like timbral structures, the rhythmic patterns of each call in a species' repertoire often display distinctive characters, providing an additional parameter by which calls may be identified by conspecifics in a soundscape. Reich similarly employs distinctive rhythmic patterns as the basis for the melodic material in *MF18M*. Particularly, the 3+2+1+2 pattern previously used in *Clapping Music* (which Potter refers to as the Basic Unit) is employed throughout the work (first appearing at the opening of Section I, bar 97), but other rapid-moving patterns (as found in Section V and IX (Fig. 5)) and contrasting sustained figures (Fig. 6) also feature.

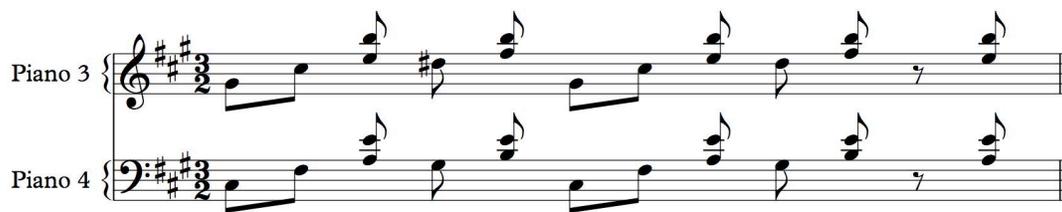


Fig. 5: Example of rapid patterns heard in Section IX



Fig. 6: Example of Section I, bb. 117-120, sustained chorus pattern

Furthermore, numerous bird species are noted for highly improvisational song structures, drawing on a repertoire of distinct vocal melodic or gestural fragments to produce complex combinatorial phrases, increasing the expressive capacity of their vocabulary and prospectively the detail of conspecific communication (Baptista & Keister, 2005; Taylor, 2010). In a similar way, the additive processes found in *MF18M* employ varying combinations of smaller rhythmic units or melodic motifs to result in intricate melodic patterns, reconfiguring (through addition and subtraction) according to underlying structural processes. One such way this is achieved is through the gradual exposition of a musical phrase by cumulatively filling out the pitch material from a singular starting note (Fig. 7).



Fig. 7: Additive process of Section VIII material, beginning with a singular note and expanding to full note sequence (first and second systems), followed by a two bar (third system), and then four bar expansion of the phrase (fourth system).

Additionally, multiple species engage in imitative dialogue, as related to the ANH (avoiding acoustic masking through temporal partitioning) as part of conspecific and interspecific communication strategies. This closely relates to imitative compositional techniques that Reich uses throughout *MF18M*. Hockets abound, both in the alternating chords pulses driving the work (Fig. 8, between Piano 1 & 2) and in larger ensemble canonic activities (heard especially in Section II as in Fig. 9, as well as Sections V and VIII).



Fig. 8: Hocket between Pianos 1 & 2 in Section I, b. 97

Fig. 9: Excerpt of Canon in Section II, b. 184

Various acoustic ecology concepts are seen at play in *MF18M*. ‘Keynotes’, defined as sounds ‘which are heard by a particular society continuously or frequently enough to form a background against which other sounds are perceived’ (Truax, 1999), are rendered throughout the persistent presence of both high and low frequency drones. These provide a harmonic background for the more fluctuating contrapuntal materials. The omnipresent pulsing treble notes played predominantly by keyboard instruments bear similarity to various animal choruses where many individual vocalisations combine to create pulsating drones, whether insectile (the stridulation of crickets or call of cicadas), amphibian (the croaking of frogs), or other chorusing species. Comparatively, lower pitched drones, such as those played by the bass clarinets and cello, resemble the periodic vibrations of commonplace anthropophony (i.e. vehicles, generators, construction tools) found in the urban soundscape, especially heightened through dynamic rise and fall at each appearance (in the manner of a passing sound source).

Additionally, the concepts of ‘sound signals’ and ‘soundmarks’ are invoked. The former term refers a sound that is intended to ‘be listened to, measured or stored... [regulating] the life of a community and [reflecting] its character’. Examples include bells, horns and sirens. The latter refers ‘to a community sound which is unique, or possesses qualities which make it specially regarded or noticed by the people in that community’ (ibid.), derived from the term

'landmark' and often having historical importance. In *MF18M*, the transitional cadence provided by the vibraphone at the end of each movement might be considered as both a sound signal and sound mark. Its timbral quality, distinct from other instrumental voices, provides a cue for all other ensemble members to prepare for a new section's material. As such, it functions as a cadential figure denoting the transition between sections (consequently marking the passage of time), like bells and horns amongst other community sounds have done so in the past.

A final connection with environmental contexts is the aspect of performative agency. Rather than existing as mere Cartesian automata, animals are understood to behave of their own volition, and interpret acoustic signals as referents to resources or other agents within their environment (Farina & Belgrano, 2006). As such, soundscape ecology research recognises a cognitive element within the soundscape, where each biological organism retains its own performative agency whilst contributing to the wider collective soundscape. Similarly, *MF18M* represents a communal environment, where both individual decision making and organised ensemble activity determine the complex sonic result. Individual and group behaviours are regulated by the score's instructions and implicit negotiations between performers in rehearsal and performance (Tomlinson, 1999), with the modular scoring calling for discretionary means of progressing the piece: the entry of a particular cueing instrument such as the bass clarinet or vibraphone left at that performer's discretion; or the length of a breath, for which the related pulsating harmonic material is sustained. In this way, Reich has created an interdependent sonic ecosystem in miniature, articulated through its macromorphological structures and micromorphological behaviours, and animated through the collective interactions and negotiations of its performers.

Discussion

It is important at this point to consider the musical cultures which influenced Reich's early musical language, which in turn take influence from the natural environment in which they were developed. The composer famously spent five weeks in 1970 in Ghana learning local drumming performance and compositional techniques, and was later exposed to Balinese Gamelan whilst in Seattle, both of which had a significant impact on the composer's then-developing compositional language.

Considering traditional musical practices, there are numerous ethnomusicological studies that have found connections between the sound cultures of peoples living close to the natural world, and the associated soundscape of their surrounds. Such examples include the B'Aka pygmy peoples of Central Africa (Sarno, 1996); the Fore (Diamond, 1993, p. 256), Bosavi (Feld,

1996, p. 91) and Kaluli (Feld, 2013) peoples of Papua New Guinea; the Nez Perce people of North America (Krause, 1993, p. 1); and the Yawur people in Western Australia (Benterrak & Muecke, 1996, p. 62). Similarly, the musical cultures with which Reich engaged have been found to bear resemblance to and/or draw inspiration from their surrounding environment (Sum, 2015).

Through drawing on these cultures and their musical techniques, it is perhaps implicit that the foundational environmental bases of each would then transfigure to the compositional result of *MF18M*. This raises several questions about the ecologically-suggestive processes and behaviours identified in *MF18M*. Are they by-products of Reich's influence of environmentally-influenced traditional world musics? Are they integrated in the work as conscious compositional choices, or the result of the process-orientated aesthetics? Is there connection between the piece and wider social movements, whether by Reich's own awareness of Schafer's work, or that of other environmentally-conscious activists? Independent analysis (Potter, 2000) and Reich's discussions of *MF18M*'s compositional process (Reich, 2000b, pp. 87-97) do not suggest an intention to draw on ecological concerns, or any connection to the environmental activism of the 1960s and 70s. Rather, it is more likely that the identified ecological behaviours are epiphenomena of Reich's masterful synthesis of basic micromorphological materials (themselves ingrained with cultural connections to the natural world) in macromorphological algorithmic processes, rendered through dynamic agential activity. Though not deliberately intended, the consequent musical result is convincingly representative of real-world soundscape experiences.

Even so, *MF18M* can still be understood as an abstracted soundscape composition when categorised according to the broad range of approaches (from 'found sound' to 'abstraction') that constitute such compositional practices. Though not directly representative of drawing from a specific soundscape, the combination of multiple soundscape-like phenomena in the work provides contextual cues towards a soundscape interpretation on the part of the listener, as proposed by Truax regarding abstract electroacoustic works (Truax, 2008, p. 107), and Hill in relation to a listener-centred, phenomenological framework for context-based composition (Hill, 2017).

In subjecting *MF18M* to ecomusicological analysis, it is apt to wonder whether it is worthwhile to analyse other abstract musical works in a similar manner. Not only might this reveal new theoretical perspectives on music that has generally been subject only to Western art music modes of analysis, but also provide insights into the perceptual experiences of such music, through the lens of psychoacoustics and bioacoustics (which inform the cognitive dimensions of ecoacoustic research). Additionally, consideration of how soundscape (and related cultural byproducts such as world musics) may influence a composer may

prove useful in understanding the relationship between acoustic environment and creative practitioner.

As a succinct summary of the work, and a description of his “immediate visceral and emotional reaction to the repetition and pattern making” of *MF18M* at his first listen, composer Nico Muhly says:

“The thing about that piece is that there’s a million things going on at once, but it’s also incredibly simple. It’s music that’s existing for me at two different speeds... the visceral experience is one of flying over a landscape, and the feeling of speed, but then also the feeling of incredible detail. So it’s like you’re at a distance but incredibly close. There’s a way that you can argue that that piece is very, very slow. It’s just these 11 chords that then you zoom into the chord and see who’s inside and then you zoom out and then you zoom in, and you can say that the hour is just these big breaths and that’s it, these gigantic camera moves. And then you can argue that it’s all this little kinetic information that is interlocking and precise. And what’s also great about that piece is that despite its precision, there’s a lot of flexibility in terms of how long you repeat things, who’s in charge... you wait for these clarinets to finish this thing and then you move on, and the vibraphone does this and then you move on, so it’s a kind of community exercise. And the first time I heard it I felt that it was such a beautiful and impossibly precise analysis of what it feels like to listen in general.” (Millman, 2016)

In tandem with its critical acclaim and recognition as a significant minimalist work (Colter Walls, 2016), and again echoing the aforementioned relationship between macrocosm and microcosm, many like Muhly have expressed similar impassioned responses to initial and subsequent hearings of *MF18M*, recognising invigorating and restorative qualities from listening to the work.

From an aesthetic perspective, this might result from Reich’s channeling of Balinese music, which is rooted in the cosmological and aesthetic concept of *ramé* (‘crowded’): “*Ramé* indicates the heightened excitement one feels when experience coincident multiple layers of meaning, sound, colour and events.” (McKee 1994, in Tomlinson, 1999, p. 26). In turn, the importance of *Ramé* to Balinese gamelan rests in the musical culture’s derivation from and connection to the local natural soundscape, which is highly dynamic and acoustically vibrant with its subequatorial ecosystems.

The physiological benefits of natural soundscape listening are increasingly recognised, as articulated by Lacey and Harvey: “Pre-modern listeners were entrained to the locus of the soundscape composition relative to their acoustic horizon. Human entrainment to a healthy soundscape leads to a healthy human

spirit in relation to the autonomic nervous system..., emotional sense of place ... and a sensitive awareness of the environment; thus, soundscape and entrainment are related by the bodily response of the listening individual” (2011, pp. 10-11). This observation is supported by numerous studies indicating somatic and psychological benefits for soundscape listening (Aghaie et al., 2014; Alvarsson, Wiens, & Nilsson, 2010), as well as increasing understanding of innate human physiological responses to sonic stimuli (Patton, 2003, p. 3).

Given the connections between MF18M and the natural world identified above, further ecomusicological investigation of other musics (especially those not categorised as ‘environmental’) may shed light on their perceived ameliorative qualities, and potentially identify new creative compositional strategies for therapeutic music projects.

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