Scorescapes:
On Sound, Environment and Sonic Consciousness

PROEFSCHRIFT

Ter verkrijging van de graad van Doctor aan de Universiteit Leiden,
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door

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Promotiecommissie:

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Dit proefschrift is geschreven als een gedeeltelijke vervulling van de vereisten voor het doctoraatsprogramma docARTES. De overblijvende vereiste bestaat uit een demonstratie van de onderzoeksresultaten in de vorm van een artistieke presentatie.

Het docARTES programma is georganiseerd door het Orpheus Instituut te Gent.

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Scorescapes: On Sound, Environment and Sonic Consciousness

1. Introduction: Sound Art and Environment

1.1 Sound and Environment from Practice

Scorescapes explores sound, its image, and its role in relating humans and their technologies to the environment, embodying research in and through artistic practice. It investigates how qualities of sound can open up ways of thinking and experiencing urban, rural and extreme environments that may lead to a greater understanding of our relationship to those environments. This thesis explores the related questions of, first, how does sound mediate our relationship to environment, and second, how can contemporary multidisciplinary art practices articulate and explore this relation between sound and environment. The compositions and art works I have developed as part of the Scorescapes research build on my earlier works since the late 1990s to investigate these questions in a variety of ways: through sound walks with specially designed instruments, field recordings used in performance, site-specific audio-visual installations, graphic images, and collaborative performer-audience compositions.

I use the term "environment" as a general and inclusive notion. It encompasses relationships between levels of natural, human and media environments that are built on top of each other and interpenetrate. Sound is a fundamental part of the environment in general and binds us to it, opening up aspects of awareness and meaning that may be overlooked in visually dominant cultures. Through my research on sound and environment, I have noted the following basic characteristics of sound as a medium: sound is contextual; it propagates and exists beyond boundaries of material matter, and so provokes relationships between sometimes distant beings in the human social world, the larger environment and non-human ecologies. Sound's medium is air or water or solid matter, in vibration, containing information for a receiver about how it came into being. This forms a fundamental basis for interactions between diverse ecosystems of plants and animals. Because sound is both temporal and spatial, it blurs the distinctions between concepts of time and space. And sound resonates beyond its immediacy as something physically sensed and heard in the present moment, to an existence in memory and as a trigger for future psychological and associative meanings and behaviours. The insights just described on the characteristics of sound and how it forms relationship to the environment inform both my artistic practice and the theoretical considerations addressed in this dissertation.

The more I create artworks that interrogate relationship to the environment, the more I find that the situations I instigate are largely of a psychological nature. Each environment influences how we interact with it practically and emotionally. This interaction is not something that can be defined once, even with constant exposure to the same environment, but is constantly being redefined and renegotiated. With every new work I present, and with every new performance of it, the act of questioning and discovering a relationship to environment happens again, and in a different live form. These artworks and performances have led me to understand that activating sonic relationships with the environment opens up people's awareness and attitudes to the world around them. In order to do this I have had to question ideas that put the audience in the position of a *passive* listener or onlooker (as in traditional visual art and classical music). Such situations impair the listeners' ability to interact with their surroundings making experience of environment remote. It hinders the audiences' interaction with the environment and the artist / composers ability to harness the dynamic potential of environmental interaction in their work. However, by being open to sound and listening, these assumptions or 'filters', to use composer Pauline Oliveros' term (Oliveros, 2005), can be lifted to create the conditions to generate meaningful relationships to the environment and other people by being actively involved and immersed.

1.2 Towards an Active Engagement with Environment

My artistic work explores the dynamic relationships between the environment and our cultural attempts to understand our place within it through the use of sound. I take an active approach to this, starting from the idea that we cannot observe as if from the outside but that we are implicitly involved in the environments we study and experience. This sense of of active engagement requires a shift in perspective and a re-learning of bodily and conscious qualities related to awareness. I am interested in both a techno-scientific understanding of environment, emphasising the interconnectedness of ecologies and systems, and a non-technological approach, attuning awareness of non-human environments through mind and body practices. The research presented in this thesis aims to learn more about the different ways in which the relationship between technological and non-technological practices embed us within the larger systems of our environment.

There is a long tradition of artists and musicians engaging with the topic of environment in their work. Particularly in the last half century there has developed a foundational discourse around sound, place and environment rooted in the work of Land Art and the Acoustic

Ecology movement, both emerging in the 1970's. Land Art, pioneered by artists such as Robert Smithson and Richard Long, used elements of the landscape itself as artistic material, often in remote wilderness locations, challenging assumptions about the gallery system of the visual art world. Acoustic Ecology, the study of sonic relationships between the environment and living beings, grew out of the World Soundscape Project begun in Canada by composers R. Murray Schafer, Barry Truax and Hildegard Westerkamp and has developed into an international forum for soundscape studies. These artistic developments coincided with a popular and important environmental movement that held as one of its symbols the underwater recordings of the songs of the humpback whale, recorded by biologist and environmentalist Roger Payne and scientific journalist Scott McVay (Payne and McVay, 1971). These and other examples of contemporary art no longer simply represented landscape, but started to engage directly in the site and material of environment, and in doing so fundamentally challenged the presentation of these ideas within an exclusive urban gallery or concert setting.

This new emphasis on the direct engagement with environment relied on the increased importance of actively understanding how, what and why we listen. Rather than being a somewhat passive receiver of sound, listening is an active process that is as much internal or cognitive as it is external. By the 1970s, composer and sound theorist Schafer, considered the founder of the Acoustic Ecology movement, explored in depth what he called the 'soundscape'. This involved the categorisation of sound in terms of both how it is produced but also how we listen (Schafer, 1977). Such concerns were shared by Schafer's contemporaries, including composers like Alvin Lucier and Pauline Oliveros whose work demands an attention and commitment to active engagement with listening to create meaning and make the piece (Lucier, 1995; Oliveros, 2005). These composers all use technologies to explore this aspect of listening, and the interrelationship between technology, sound and environment is fundamental to an understanding of this active engagement.

Given this background I have identified the following research questions for my own current experimental practice.

- How are contemporary music and sound art practices continuing to address issues of sound and the environment beyond the foundations laid by Acoustic Ecology?

- By rethinking the 'soundscape' of Acoustic Ecology, is it possible to propose an active participation in the environment?

- Can the in-depth study of sound in the environment radically challenge assumptions about music?

- Building on musical conventions can the combination of score and environment provide a conceptual base towards a flexible way to rethink structural processes and interpretations?

- What is the relationship between our physiological abilities and our technological extensions in sounds and environment?

- Can the study of environmental sound open up transdisciplinary discourses across the arts and sciences?

- How can artistic research address the issue of environmental sustainability and in doing so suggest new roles and responsibilities for composers and artists?

To address these questions, I draw on theories of sound as relational, spatial and immersive as well as scientific examples particularly from bio-acoustics. Interdisciplinary notions of art-science collaboration are a central theme, as are experiments undertaken in my own artistic practice and my research on the numerous ways in which sound artists work with environmental sound. In particular, I consider how Lucier and Oliveros, composer and sound artist David Dunn, and marine bio-acoustic scientist Michel André are all actively involved as listeners in the ways they use sound. Each of their practices shares distinct concerns, including: making the inaudible audible, psychoacoustic phenomena, meditative deep listening practices, distributed sonic consciousness, technological interventions, spatial awareness, temporal scales, non-human ecologies. In several cases the presentation of their work often occurs independently of musical performance venues, and even has greatest impact outside of specifically musical or art world limits. These people have been inspirational to me in finding responses to my ongoing central concern: to develop an artistic practice that actively relates to and embeds us within our environment with acute awareness so that we can act with greater empathy and responsibility towards it.

To investigate this active, practical, embodied engagement and understand its theoretical implications and potential future directions, I became actively involved in the following ways. I completed a residency with Lucier at the Atlantic Center for the Arts in Florida where along with seven other composers we collaboratively performed and interpreted some of his seminal works. I attended a week long Deep Listening Retreat with Oliveros in Nau Coclea Art Center in Spain to extend my understanding of her work through practice and

direct experience of her techniques. I have discussed many issues with Dunn (and his scientific collaborator James Crutchfield), including practical work with microphones, field recordings, and discussions about art-science collaborations. I initiated visits and set the ground for a collaboration with Michel André from the Politecnic University of Catalunya (UPC) Barcelona, at his lab located in the fishing harbour of Vilanova in Spain. There I explored their tools, techniques and methodologies in situ, and discussed potential collaborative projects for the future.

In my own artistic work, which I have been developing since the mid 1990s, I use environmental sound recordings, underwater recordings, video and technological experiments with interfaces and instruments. These take the form of installations, performances, lectures and writings. The works themselves arise out of immersion in the ideas as responses to certain environments. I intend for the experience of my work to provoke in the audience questions and raise awareness about issues of environment, embodied listening, music and sound and sustainability. I try to make the works very open, so they do not necessarily provoke one specific question, but offer interpretative possibilities to the one who experiences them, rather like an 'open score'. The experience of making and publicly presenting these works in professional exhibitions and festivals has required them to reach a completed stage. As an artistic research method, the process of finding, resolving, completing and presenting new work and then gathering responses from the public, feeds back into the research questions and influences my future projects.

1.3 Background Theories: Sound Art as an Emerging Interdisciplinary Field

Sound art is hard to identify as an independent genre as it overlaps with music, visual art, media art, architecture, spoken word and performance. Although sound art has been developing since the 1970s, with notable earlier influences from Futurist painter and composer Luigi Russolo to American composer John Cage, its histories and theories are only being written more recently. Indeed sound is currently a topic of great interest with numerous new book titles being published. However, as an artform, sound art has been somewhat slow in gaining recognition and influence on artistic and intellectual grounds. Indeed most art forms, in particular the visual arts, have developed in a kind of symbiosis with the theory that defines them. The history of art and technology, now known as media art or New Media, is deeply entwined with sound yet it has developed far greater weight and impact, perhaps largely because of its visual, textual and technological references. Sound art

builds partly on a musical framework, language and analysis, but these musical concerns are specialised and unfamiliar to visual arts, architecture and their theories. This has made it difficult to bridge disciplinary divides in academia and produce comprehensive, useful theories of sound art that embrace the necessity of synthesis among these disciplines.

A few individuals have risen to this challenge, and begun to map out a history of sound art through its relationship to other arts. Theorist Douglas Kahn's *Noise, Water, Meat: a History of Sound in the Arts* (1999) remains the most comprehensive overview of the major intellectual themes that run through the practice of sound art. More recently, artist and writer Brandon LaBelle has offered a further view, in *Background Noise: Perspectives on Sound Art* (2007). Dealing with the topic of sound and its relation to space, LaBelle maps out case-studies from major artistic movements since the 1950s, revealing sound arts inextricable links to the edges of experimental music, visual art, architecture and media arts. These two scholarly volumes are complemented by the more journalistic and anecdotal style of writer and musician David Toop whose *Haunted Weather: Music, Silence and Memory* (2004), weaves together places, memories, sounds, experiences, names, associations, drawings, into an impression of sonic-like diversity and resonance. It is notable that all three authors have practical experience and training in the making of music and sound art. These books stand in contrast to the only notable general anthology of writings on sound art, *Audio Culture: Readings in Modern Music (*2006), edited by philosopher Christoph Cox. This highly edited and idiosyncratic selection of key writings by sound artists and theorists unfortunately narrows the field by its omissions. As a result, *Audio Culture* reads as if scratching the surface of some topics and is not particularly successful at following and joining the threads that lead through the various themes and chapters.

Coming back to Kahn and LaBelle, *Noise Water Meat* and *Background Noise* trace sound through the twentieth century, demonstrating its role in forming and transforming the visual arts in the 1960s and 1970s, thereby laying the ground for sound art becoming a recognisable genre of its own in the 1990s and 2000s. While Kahn draws together a number of threads beginning early in the twentieth century, LaBelle's aim is to "locate the practice of sound art from the early 1950s to the present" and "to locate sound's point of origin, as a spatial and historical coordinate" (LaBelle, 2007: 295). Both authors give Cage the foundational ground, but analysed in terms of his influence on the visual and performance arts rather than exclusively music. And both authors contextualise the current rediscovery of sound within a visually biased and technologically developing culture. This broadening of sources and attempts at synthesis of a number of different fields and discourses is

characteristic of sound art, and presents one of the main ongoing challenges for research, production and dissemination.

LaBelle constructs a theory of sound art as 'relational' through historical examples, unfolding a compelling argument for the relevance of sound to contemporary culture, and articulating the complex relationships between sound and space. He traces the origins of sound art back to the contrasting approaches of Cage and electronic music pioneer Pierre Schaeffer in the 1950s and discusses the appearance of sound in process and event-based Happenings, Fluxus, Minimalism and Conceptual Art of the 1960s. Building on Steven Connor's theories of the voice in his book *Dumbstruck: A Cultural History of Ventriloquism* (Connor, 2000) (and indeed on Kahn although he is not explicitly referred to) LaBelle examines the charged relationship of voice to space and questions of public / private in Performance Art of the 1970s, including Lucier. Expanding on questions of space and site-specificity, he considers sound in relation to architectural space and the development of sound installations. LaBelle bases the aesthetic concern with environmental issues of noise pollution in the soundscapes of Acoustic Ecology, relates it to the Land Art movement of the 1970s and contrasts it with later noise and environment works and sound walks up until the 2000s. Finally, he considers the dramatic transformation of sound and its uses and affects by networked digital space in the 90s and 2000s. In his conclusion, LaBelle observes sound art as a binding cross-disciplinary form resonant with the theories and practices of digital media, a theme covered in greater detail by theorist Francis Dyson in her more recent book *Sounding New Media* (Dyson, 2009). He offers suggestions as to why sound should be so pertinent to twenty-first century thought, and proposes a role that sound art can play in articulating this: "Sound as media and as idea", he claims, "may provide an appropriate paradigm for negotiating the intensifications of non-hierarchical and interpenetrating structures of our digital age". He further proposes that, "its ultimate contribution may be found in being contextual and relational" (LaBelle, 2008: 297-8).

From the two fundaments of sound and space, tracing a history through the artworks of the late 1960s, which emerged as site-specific and process-based rather than object-oriented, LaBelle argues that experimental visual art constitutes a mode of artistic enquiry profoundly akin to the workings of sound. "The very move away from objects towards environments, from a single object of attention and toward a multiplicity of viewpoints, from the body toward others, describes the very relational, spatial and temporal nature of sound itself." Further, by choosing the world 'relational', LaBelle is making reference to the influential contemporary visual art theory formulated by Nicolas Bourriaud in *Relational Aesthetics*

(1998/2002), in which, exclusively in the realm of visual art, and without historical precedents according to Bourriaud, contemporary artists are creating situations of a social rather than visual nature. Although LaBelle only refers to this somewhat controversial and exclusionary theory in passing (to critique it as being not inclusive enough of sound art that has these concerns at its centre for a longer time) its influence is notable if contested. (LaBelle, 2007: 248-9). By embedding sound art within these artistic and theoretical contexts LaBelle paves the way for a discourse of sound that is not only reliant on that of music. He bridges the discourses of the visual arts, architecture, music and new media in order to give voice to sound art as a form of practice that has its own structures, concepts and views.

The contextual and relational nature of sound opens up various ways of listening, understanding and experiencing situations and environments. LaBelle's substantial contribution to outlining the field of sound art provides valuable insights for further investigation and discussion. *Background Noise* is an inspired and thorough opening in an expansive field of ideas that are necessary for the formulation and progression of practices using sound. The expansive, if not paradoxical nature of sound, is made manifest in LaBelle's claim that,

> Sound is intrinsically and unignorably relational: it emanates, propagates, communicates, vibrates, and agitates; it leaves a body and enters others; it binds and unhinges, harmonizes and traumatizes; it sends the body moving, the mind dreaming, the air oscillating. It seemingly eludes definition, while having profound effect. (LaBelle, 2007: ix)

I find this a useful evocation of the apparent contradictions in the use of sound, and it resonates with the various questions confronted in my practical work. I am attempting not so much to *describe* sound, as LaBelle is in this book, but to create *situations* where sound can affect and activate people's experiences in a personal way (LaBelle does this also in his sound works). Recognising the interaction between sound and space implies not simply describing works as activating acoustic properties on a technical level, but creatively understanding the implications for someone experiencing it. I understand LaBelle's ideas of the 'relational' qualities of sound, to be tied fundamentally to the relationship between listeners and sounds, and the environment they occupy and construct through the process of making sound and listening in particular spaces. It is therefore a personal and embodied experience within sound and space.

1.4 Scorescapes Dissertation Overview

In order to adequately explore the various facets of this research project, and relate it to developments in my own practical work, I have chosen a subject-oriented approach rather than a chronological or historiographical one. Many of the same issues recur throughout the chapters, and I have attempted to introduce the most fundamental concepts towards the beginning, expanding these through more specific examples in the central portion and leading towards a more open-ended final chapter of personal speculations for future directions.

The second and third chapters (coming after the introduction) provide the rationale behind my term 'scorescapes'. In chapter two, Score, I outline both my personal artistic interest in the development of the notion of a score beyond a document for notation, and provide theoretical arguments and historical examples to suggest that the score can also exist in the mind and in space. I bind notions of score and place through experiments with mapping and navigation in my work *Taking Soundings*. Further, I explore the role of navigation developments and techniques, and the role of mapping in linking an embodied with an abstract model or notation of environment. This leads to the proposal that the score facilitates *relationship,* as exemplified in my work *Sun Run Sun*. Finally I note that this transformation of the role of the score from notation to relationship signals a different attitude to composition, where research becomes a fundamental component.

The third chapter, Scape, sets a ground for the question - what is it to 'relate to environment' through sound? I begin by rethinking the influences of Acoustic Ecology and Land Art from the 1970s in terms relevant to the environmental context of today. I further contextualise ideas on environment and ecology as influenced by systems aesthetics and cybernetics that describe complex interlocking systems in homeostasis and exhibiting feedback. In this context I discuss the theories of Dunn that investigate interaction with landscape. This leads to a more specific idea of *walking* as an active engagement with the environment, a form common to both Acoustic Ecology and Land Art, and recurring through sound walks to the present, including the role of walking in my own work. In these two initial chapters I develop the notion of scorescapes as areas of action within sound and environment.

The central three chapters (four, five and six) go into considerably more depth on specific topics: making the inaudible audible, underwater sound and attitudes to field recording. In chapter four, Inaudible, the physiological limitations of the human hearing range within larger environmental soundscapes highlight the necessity of making the humanly inaudible audible.

Techniques of audification, sonification and visualisation are compared and clarified, with examples from Dunn and sound artist specialising in sonification Andréa Polli. I illustrate the role of interpretation and compositional choice when sonifying data by analyzing my own working process in *Sun Run Sun*. The chapter concludes with emphasizing the necessity and role of informed listening when considering otherwise inaudible sound.

Perhaps the most pertinent example of an environment where sound is not perceivable to humans without technical aid, is underwater. Relatively little is known about underwater sound. Chapter five, Whale, goes into detail on the necessity but difficulty of understanding the sonic qualities of this alien environment that functions largely through sound. I give an analysis of the seminal humpback whale song paper (already mentioned) by Payne and McVay and contrast it with the recent work on sperm whale clicks by André. Lucier's *Quasimodo*, inspired by the humpback's ability to send sound over vast distances, raises discussion of long distance sound and communication. The analysis of dolphin sound by scientist John Lilly explores interspecies communication through sound, and is compared with current attempts to 'communicate' through music with whales. These researches all point towards complex issues of noise pollution and mitigation within the ocean system. My installation *Pink Noise* and performance *Fishing for Sound* are practical works intervening in this context.

Chapter six, Field, addresses questions of place in field recordings, the replacing of sound from one location to another, and proposes a possible interactive role in environments through recordings. Building on writer and art critic John Berger's notion of 'field' as a contemplative state of mind induced by the daydream, I discuss techniques of listening developed by Oliveros and Schafer. These non-technological methods of listening are complemented by scientific bio-acoustic techniques of analyzing and describing sonic ecosystems. I propose the potential of active intervention through 'passive acoustic' technologies that analyse environmental sound by listening rather than producing sound. This discussion sets the stage for considering ways of activating an embodied interaction with field recordings in artistic presentations in general and my performances with acoustic musicians, *SWAMP 1 & 2 & 3*.

The concluding chapter, Flare, is an attempt to synthesise the array of ideas that developed during this research, absorbing most of the topics covered in the previous chapters, but taking a more personal turn. I locate issues relating to the development of my work within personal experience with PTSD (Post-Traumatic Stress Disorder) and sound therapy. I describe interdisciplinarity through sound and image in environment in works such as *Pink Noise* and *Tropical Storm*. This leads to questions of explosion, energy and sonic vibration,

linking technology as a figure defining active and embodied relationships to environment, in particular the impact of instruments and sound technology on ways of listening and understanding environmental context. I compare EMDR (Eye-Movement Desensitization and Reprocessing) sound therapy with dream and listening techniques by Oliveros in her Deep Listening Retreats, describing my performances *Fishing for Sound* and *Therapy for Future Flooding*. I propose a notion of 'techno-intuition', which blends the technological and non-technological approaches of instrument and intuition, through physical practice, listening and experimentation.

1.5 Overview of Creative Works presented as part of this Research Project

Taking Soundings

3 colour prints and sound, 9 tracks total playing time 15 minutes.

Taking Soundings is a research project into sound, landscape and new technologies, combined to create 'coastlines' of sound. It takes various forms of performances, installation and writings, and centers around the use of GPS navigation technology and sound. The title refers to a technique of determining the depth of water beneath a boat using lead and line, essential to coastal navigation in shallow waters. The final and most recently exhibited works from this project are three colour prints generated during performance combined with a sound work of electronic sonifications of GPS data and other navigation techniques including lighthouse signaling and environmental field recordings.

Taking Soundings was developed and presented during an Artistic Fellowship at the Academy of Media Arts Cologne, and an Artistic Residency at STEIM, Amsterdam 2006-7

'Possibility of Action: the Life of the Score', MACBA, Barcelona, June-October 2008
'Ground Level', Hayward Touring UK, June 2010 – April 2011

Sun Run Sun
Handheld GPS instruments; sound and data installation; sound performance; sound composition.

Sun Run Sun investigates contemporary, historical and animal techniques of navigation through the use of sound. Charting a path between environmental engagement and technological development, Sun Run Sun explores the relationship between the embodied experience of location and the calculated data of position. A continuously changing musical composition is generated from signals of navigation satellites in orbit, together with the participant's coordinates on earth. By exploring the individual experience of navigation technologies through the intimate and immersive qualities of sound, it re-establishes and renegotiates a sense of embodied connectedness to one's environment.

Sun Run Sun: Satellite Sounders
The Satellite Sounders are handheld custom-made instruments that allow one to listen to the changing satellite data while walking. They consist of a GPS antenna and receiver, a small computer processor converting the data into sound, a rechargeable battery and stereo headphones, and experienced whilst walking.

Sun Run Sun: Dead Reckoning
Dead Reckoning is a site-specific, multi-channel sound and data projection installation. Sound is generated from a fixed GPS receiver that continuously calculates a different position, emphasizing the satellites in motion at an apparently drifting location.

Sun Run Sun: Sun Running
The sound performance *Sun Running*, combines recordings of satellite sounds from around the world with environmental recordings and voices of participant reactions to the Satellite Sounders.

Sun Run Sun: Satellite Sounding
A seven minute sound composition using recordings from pubic walks with the Satellite Sounders. In this sound piece the reactions of the public, who become the performers, combined with the recorded satellite sounds collected from four corners of the world, activates an imaginative space of both dreams and suspicions enacted above the everyday.

Sun Run Sun was produced by NIMK (Netherlands Media Art Institute) during the Artist in Residence, November 2007 – April 2008 in collaboration with STEIM (Studio for Electro-Instrumental Music) Amsterdam.

Sun Run Sun was presented in the different versions and as artist lectures followed by demonstrations at the following locations between April 2008 and December 2009:

Sun Run Sun: Satellite Sounders, 'Playing the City', Schirn Kunsthalle, Frankfurt
Sun Run Sun: Satellite Sounding, 'LuisterSalon', Arti et Amicitiae, Amsterdam
Sun Run Sun: Satellite Sounding, WEALR09, California State University, Los Angeles
Sun Run Sun: Sun Running, Netherlands Royal Society of Musicology, Utrecht
Sun Run Sun: Satellite Sounding, 'LuisterSalon', Korzo, Den Haag
Sun Run Sun: Sun Running, 'Re:Visie', Netherlands Film Festival, Utrecht
Sun Run Sun: Satellite Sounders, PICNIC08 Virtueel Platform, Amsterdam
Sun Run Sun: artist lecture, Royal College of Music, London
Sun Run Sun: artist lecture, ISEA08, Singapore
Sun Run Sun: artist lecture, Orpheus Institute for Advanced Research in Music, Ghent
Sun Run Sun: Satellite Sounders, NIME08, Museum of Contemporary Art, Genova
S*un Run Sun: Satellite Sounders*, Temporary Museum 2008, Amsterdam
Sun Run Sun: artist lecture, Design Media Arts, UCLA, Los Angeles
Sun Run Sun: Satellite Sounders, V2_Institute for Unstable Media, Rotterdam
Sun Run Sun: Sun Running, STEIM (Studio for Electro-Instrumental Music), Amsterdam
Sun Run Sun: artist lecture, Netherlands Media Art Institute, Amsterdam
Sun Run Sun: Satellite Sounders, NIMK (Netherlands Media Art Institute), Amsterdam
Sun Run Sun: Dead Reckoning, NIMK (Netherlands Media Art Institute), Amsterdam
Sun Run Sun: artist lecture, Mediamatic, Amsterdam
Sun Run Sun: Sun Running, Dag in de Branding Festival, TAG, Den Haag

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Navigating by Circles or *Sextant*
Single channel video, stereo sound installation.

Looking through the lens of a sextant, trying to fix the sun on the horizon from a moving boat, the sounds are electronic sonifications of the same process done by GPS.

CCNOA (Center for Contemporary Non-Objective Art) Brussels 2007
'Eco-Aesthetics', TAG, Den Haag 2008
'Ground Level', Hayward Touring UK, June 2010 – April 2011

Hydro 1 & 2
Performance.
#1: field recordings and live electronics.
#2: field recordings, live electronics (Yolande Harris) and contrabass flute (Ned McGowan).

Musical experiments into the sounds of underwater creatures and the aqueous properties of the contra-bass flute.

Karnatic Lab , Muziekcentrum De Badkuyp, Amsterdam, February 2009.
Karnatic Lab , Muziekcentrum De Badkuyp, Amsterdam, March 2009.

Ponce Inlet
6 channel sound composition from field recordings.
Collaboration with sound artists Erik DeLuca and Charles Stankievech.

Ponce Inlet is an immersive, spatialised, hypnotic sonic exploration of a narrow body of water, an entrance, which connects the Atlantic Ocean to the Intracoastal waterway and the Indian River in Florida. The material for the composition was recorded with an array of three hydrophones, mapped by the triangular shape of a boat's hull and a set of air microphones used to capture the simultaneous sounds produced in air.

'Alvin Lucier Residency', Atlantic Center for the Arts, Florida, June 2009
Herbert and Nicole Wertheim Performing Arts Center, Miami, Florida, November 2009

Bell Buoy
Single channel video projection.

The visual counterpart to *Ponce Inlet*, *Bell Buoy* is an image of an Atlantic buoy marking the entrance to the Ponce Inlet channel. A bell mounted on the buoy makes sound with every shift of the ocean surface. An analogue form of sonification of the sea state. The silent video prefaces the sounds of *Ponce Inlet* in which the bell is audible from beneath the water.

'Alvin Lucier Residency', Atlantic Center for the Arts, Florida, June 2009

Tropical Storm
Installation: single channel video (room sized projection), stereo sound (dispersed).

Sound and video recordings of a tropical storm evoke the multisensory experience of being immersed in a torrential downpour in a rainforest. *Tropical Storm* presents the intensity of noise and energy through minimal editing, allowing the exact synchronisation of sound and image to work up an affective space of palpable intensity that can be both overwhelming and meditative.

'Alvin Lucier Residency', Atlantic Center for the Arts, Florida, June 2009
'Sonic Unconscious', Issue Project Room, Brooklyn New York, April 2011

Scorescape Spectrograms

A series of images made from the field recordings using spectrogram imaging. Including *An Image of the Sound of Dolphins Echolocating* and *Image of the Sound of Rain.* Presented in "Now Stripe Time: On tropical rain, dolphins echolocation and the pink noise of pleasure yachts in turquoise sea" and other lecture performances.

DNK concert series, Smart Project Space, Amsterdam, September 2009

Walking Piece
Binaural microphones, sound recordings, sound playback device, headphones.

The recording of sounds of a walk along a specific route are played back to individuals on headphones who are instructed to make the same walk but at a different time. The shift in relationship between the location seen and the sounds heard provokes a perceptual awareness of our reliance on sound and its influence on the visual and on our sense of place.

Orpheus Institute for Advanced Research in Music, Ghent, Belgium, January 2010

Field
Installation, single channel video, stereo sound

Recordings in a country field in spring. The distant sounds reveal how sound is not limited to the physical boundaries of a field.

Galerie Mario Mazolli, Berlin, June 2010

2x2: Therapy for Future Flooding
2 instruments of the same kind, 2 participating listeners, mechanical pendulum metronome.

2x2: Therapy for Future Flooding is a musical composition consisting of a graphic and text score. It provokes dream-like communication within a confined space between two musicians and two audience members in an intimate atmosphere reminiscent of a therapy session.

Commissioned by Machine Project for the Little William Theater Festival of New Music.

Hammer Museum, UCLA, Los Angeles, September 2010

Sail
Installation, single channel video, stereo sound (in process).

Recordings under sail in rough sea, sound from interior hull of boat.

'Water and the World', Ear to the Earth Festival, EMF, New York, November 2010

Swim
Installation, single channel video, stereo sound.

Recordings from an ocean swimmers viewpoint, it captures the rhythm of breathing and physical motion as the sound and image alternate between above and below water, cutting through the surface exploring the physicality of sound in relation through a direct involvement with environment.

'Water and the World', Ear to the Earth Festival, EMF, New York, November 2010
'Dump Time: For a Practice of Horizontality', Shedhalle, Zurich, March 2011
'Sonic Unconscious', Issue Project Room, Brooklyn New York, April 2011

S.W.A.M.P. (Some Wayward Attempts at Monitoring Prawns)
Performance, field recordings (Yolande Harris) and acoustic improvisation, with:
#1 Christopher Williams (bass) Kato Hideki (electric bass) Stephen Menotti (trombone)
#2 Christopher Williams (bass) Morton Olsen (bass drum) Werner Dafedecker (bass)
#3 Kato Hideki (electric bass) William Lang (trombone) and Jim Pugliese (percussion)

S.W.A.M.P. explores the edges between field recording and acoustic improvisation, between sound and music. Environmental and underwater sounds, from biological to anthropogenic, lead to a state of mind that builds on the daydream.

#1 Diapason Gallery Brooklyn, New York, June 2009
#2 Galerie Mario Mazolli, Berlin, June 2010
#3 'Sonic Unconscious', Issue Project Room, Brooklyn New York, April 2011

Tuning In and Spacing Out
Performative lecture: projection, stereo sound.
Collaboration with art historian Edward Shanken.

Tuning In and Spacing Out: The Art and Science of the Presentness of Sound
Is a collaborative lecture/performance that explores sound and space as modes of understanding environmental phenomena. Edward Shanken and Yolande Harris draw on artistic sources ranging from Alvin Lucier and La Monte Young to Pauline Oliveros and David Dunn and on scientific research from Jim Crutchfield (complexity) and Michel André (marine bioacoustics). Blending text, sound and video, they weave together the mythic significance of marine mammals, the interconnectedness of the sea and outer-space, and the relationship between ultrasound, insects, and global climate change.

'The Poetics of Space', Sonic Acts XIII Festival, Paradiso, Amsterdam, February 2010
'Certain Sundays Sound Salon', Sowieso Neukoelln, Berlin, June 2010
Sam Fox School of Design, Washington University St Louis, US, November 2010
College of Fine Arts, University of New Mexico, Albuquerque, US, December 2010
'Sonic Unconscious', Issue Project Room, Brooklyn New York, April 2011

Fishing for Sound
Performance: stereo sound on multiple speakers (left/right split), single channel video.

Fishing for Sound creates a sea of spatial connections between phenomena underwater, in the mind, and from outer-space, weaving sounds from marine environments, psychotherapy and sonified navigation satellites. Common to each of these is a mass of background noise - of environment, memory and information - where listening is like fishing for sounds.

'The Poetics of Space', Sonic Acts XIII Festival, Paradiso, Amsterdam, February 2010
'Water and the World', Ear to the Earth Festival, EMF, New York, November 2010
'Dump Time: For a Practice of Horizontality', Shedhalle, Zurich, March 2011
'Sonic Unconscious', Issue Project Room, Brooklyn New York, April 2011

Pink Noise
Installation: single channel video (floor projection), stereo sound (headphones).

Pink Noise (The Pink Noise of Pleasure Yachts in Turquoise Sea) uses sound recorded underwater at a National Marine Reserve in midsummer. A surprising range of sounds - loud thumps, grinds and tones from boat engines, anchors and depth sounders - are juxtaposed with video of colorful light reflecting on the sea from the same location. Headphones are suspended from the ceiling directly above the video projection on the floor, physically emphasizing the technological mediation required to make audible the inaudible underwater sounds.

'Esemplasticism', Club Transmediale, Berlin, February 2010
'Sonic Unconscious', Issue Project Room, Brooklyn New York, April 2011
'Alternative Now' WRO Media Art Biennale, Wroclaw, Poland, May 2011

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2. Score: the Score as Environment and the Environment as Score

2.1 Scores Re-Imagined

Since the mid twentieth century, musical practices exposed the limitations of conventional Western notation in a variety of ways. Non-tempered tuning systems using different divisions of the octave may require a notation beyond the five line staff. Notations for exploring extended instrumental techniques must be invented graphically and descriptively explained with footnotes or a key. Explorations into graphic scores, where visual imagery and spatial layout take the place of conventional notations, composer Cornelius Cardew's *Treatise* (1971) being perhaps the most extreme, laid greater emphasis on the audio-visual interpretation. 'Event scores' often made as instructions in text and developed in Fluxus performance art by Alison Knowles, Yoko Ono, La Monte Young and others, opened up possibilities of a changing relationship between composer and performer, whereby the composer offered suggestions of possible interpretations, and the performer entered into the music more in the role of a collaboration. Improvisation, sound art and electronic music appeared to make the score in the traditional sense superfluous in that there was no necessary communication between composer and performer. Indeed, the musical structures and processes of these forms suggest a very different idea of a score that contains memories, spatial practices and technical processes, audio-visual combinations and sound recordings among others.

In order to understand the relevance of the score in today's practice and technological environment, a complete rethinking is required. Any form of notation or 'translation' into coded form, emphasises some aspects over others. The choice of which parameters to translate and represent, and how, is part of the interpretative mapping. This is a key point in sonifications, audifications and visualisations, and translations from any form into another media. The score is therefore just one specialised example in a larger array of concerns.

2.2 The Score as a Bridge between Sound, Self and Environment

This chapter re-thinks the musical score as conceptually relevant for cross-media issues encountered in sound art, electronic music and audio-visual practices. These multi-disciplinary practices have developed over the last century alongside purely musical practice.

I often ask myself how the score is relevant to my work. I continually come back to the idea that, even in sound art works without the traditional composer-performer-text relationship, there are aspects of the score that are conceptually useful and need to be articulated. There is a tendency to think of the score only in terms of notational systems, as a fixed entity or as an instructional device for communication between composer and performer. Rather than conveying precise instructions, I think of notation more in terms of facilitating and articulating *relationship*, actively negotiating the gaps between time and space, the visual and the sonic, one person to another. This 'relational quality', as theorized by LaBelle and Dyson (see Introduction), is characteristic of sound itself, binding people in space in a contextual manner. The implications of this notion of relationality necessitates finding ways of conceptualizing the multitude of practices that do not build on the hierarchy and unidirectional structure of composer – performer – audience. Through a fluid notion of the score I describe my own works in mapping, navigation and audience participation, and the need for a concept of what I call 'Scorescapes'.

I consider the musical score, not as a solid entity - object-like, given, a definitive document, visual – but rather, fluid, system-like, interactive, interpretative, transductive and communicative, more like sound itself. This notion of the score, extending from the 'open' score as theorised by Umberto Eco (Eco, in Cox, 2007: 165-75, 187-8), is characteristic of the transformation of art in the late twentieth century from object to process to participation. Scorescapes takes these ideas further into sound art practices of mapping and navigation, data translation and sonification. I begin this chapter by outlining my early interest in experimenting with the notion of scores through my practical work. Next, I briefly contextualise historical transformations of the score. Following this, I analyse two classic examples from Lucier and Oliveros and introduce ideas of sound and navigation in my work.

2.3 How I arrived at the notion of Scorescapes through my practice.

My artistic practice has always been concerned with investigating the gaps between image and sound, the visual and the audible. In my early work in the mid-1990s this took the form of graphic notations, in which I experimented with visualisation techniques and differing interpretations by musicians who turn those images into sonic phenomena. I realised that the score itself was more than a vehicle for transmitting specific musical information, and could be treated rather as an arena that allowed communication and interpretation between

people. This flexible approach included the skills of improvising and challenged the visual perception of notations and their imaginative interpretation into sound.

Cardew writes of the difficulties of finding and probing this area of skills in his introduction to *Treatise* (1971), his 193 page graphic score with no instructions.

> Ninety percent of musicians are visual innocents and ignoramuses, and ironically this exacerbates the situation, since their expression or interpretation of the score is to be audible rather than visible … graphic artists do not necessarily have sufficient control of sound media to produce "sublime" musical performances. My most rewarding experiences with *Treatise* have come through people who by some fluke have (a) acquired a visual education, (b) escaped a musical education and (c) have nevertheless become musicians (Cardew, 1971: 129-30).

Inspired by Cardew, in my piece *Walking the Line* (1997), a sixty-six page book of hand-drawn, black and white ink graphics with no instructions, I worked for two weeks with another improviser and composer Sam Richards to generate a musical performance of 45 minutes for two pianos. Working on and through the implications suggested by the graphic images alone involved a process of constant negotiation between us, the score acting as a springboard for musical generation and conversation. In *Tidal Nomad Mad* (2002), written for the sixty piece Banda Municipal de Barcelona, I used only one graphic line element in an otherwise conventional notation system, where the line indicated the order of playing between each individual member of the orchestra. Without a time-signature or a conductor, the orchestra had to coordinate itself in order to move forward, and the graphic notation system encouraged an intensely concentrated dynamic, binding the orchestra members together in a way that was audible in the performance.

At the same time, walking and navigating through environments was a central part of my artistic investigations. These included a four-day walk that left a trail of sound sculptures using found material in *Walk for an Absent Public* (1996) and a seven day and night sea crossing from Florida to Bermuda in a 15 meter sailing yacht, notating sounds and navigation techniques in the famous area of absence and loss, *Sargasso Sail across the Bermuda Triangle* (1997). These projects investigated relationship of scores to environments in the absence or absent presence of an audience or public. In contrast to the traditional notation of music which precedes performance and is manifested as a written notation on a page, here the scores were discovered, imagined and enacted in environmental space. In these early pieces I was considering the score as an act of relationship through environment, rather then merely

a notational device, a concept that forms the basis of my notion of *Scorescapes* I am now elaborating.

Noting the basic discrepancy between the static image of the score and the temporal nature of the music produced, in the early 2000s I worked on dynamic visual scores using video and animation. This led me to research the interaction of sound and image in architectural space at Cambridge University, generating an MPhil dissertation and practice on the symbiosis of architecture, moving image and music through the notion of movement. I developed the idea of 'dynamic placing' where sound and image could be placed in space to interact with it and the audience, and in doing so to extend that space beyond its architectural limits. These researches developed into live interactive audio-visual performances using custom-made electronic instruments such as *The Video-Organ* (2001-3) with which I performed throughout a variety of architectural venues in Europe and delivered a paper at the NIME conference (New Instruments for Musical Expression) (Harris and Bongers, 2002). Experimenting with this 'dynamic placing' beyond internal architectural spaces and into environmental locations, we developed and performed with the Video-Walker (2003-4). This was a portable projection and sound instrument designed to carry through various environments (Harris and Bongers, 2003), once more resonating with the practice of walking in art, pioneered by land artists including Richard Long and Hamish Fulton beginning in the 1960s and more recently with locative media art among others (see chapter three for more detail on walking).

These spatial experiments led to my practice-based research project *Score Spaces* (2003-5) at the Jan van Eyck Academy in Maastricht. *Score Spaces* attempted to join my exploration of sound, space, time, movement and architecture more explicitly into an expanded spatial notion of the score. For example, I used dynamic symbols of light and sound within the environment, such as lighthouses, in the audio-visual performance *Light Phase* (2006) at the International Film Festival Thessaloniki and the sound installation *A Collection of Circles (or Pharology)* (2005) at the CCNOA (Centre for Contemporary Non-Objective Art) in Brussels. In this installation, the circular movement of sound in space, based on sonifications of lighthouses, and the bodily interaction with the sound by the use of laser beams and light sensors, generated a perceptual awareness of a physical spatial score within the space of the gallery. Although this 'score' was not visible, one was conscious of it as a map filling the space through sound. It was described as follows in art historian Edward Shanken's *Art and Electronic Media*:

> Exploring the perceptual relationship between light and sound by eliminating the former, Yolande Harris' *A Collection of Circles (or Pharology)* (2005), translates the rotating field of illumination that emanates from lighthouse looms into a 3-D sound installation in which the viewer triggers and experiences only the sonic sceptre of light, as its audible apparition revolves around a central axis, changing in response to its environment (Shanken, 2009: 19).

I developed this score space further in *Spin* (2006) for turning trombonist, quadraphonic sound, light sensors, lasers and video. Using the technical infrastructure and conceptual notions of rotation and interaction that I had developed for the *Pharology* installation described above, *Spin* explored the re-introduction of a musician into such a sound space during performance. The sounds were based on a work by Dutch composer Louis Andriessen *Rage, Rage, Against the Dying of the Light* (1966), inspired by Dylan Thomas' poem of the same name, and originally conceived for four trombonists walking along a paper score displayed around the edge of the performance space. In *Spin* the pre-recorded parts were played back around the space in a constant circular motion, while the trombonist Hilary Jeffery performed by physically spinning in circles. His motion interacted with the laser beams and light sensors, adding percussive layers to the sound playback. A video of the spinning trombonist in other locations folded other spaces and times into the circular motion of *Spin*.

Score Spaces also included *The Meta-Orchestra* (2004/5), a process-based project involving a group of multi-disciplinary musicians, artists, designers and engineers, using electronic extensions to their instruments and tools (Harris, 2005). In the site of a 20,000 square meter abandoned coalmine in Belgium, this group explored the dynamics of group improvisation extended over wireless networks and vastly reverberant natural acoustics. The digital networked technologies provoked questions of leadership and collaboration, and a dynamic interactive notion of the score. It also demanded an analysis of space and instrument that was broader than one instrumentalist, leading to the publication 'The Building as Instrument' (Harris, 2007c). The changing relationship between body, instrument and score as provoked by technology became a central notion in this research, leading to another publication in a special issue of the *Contemporary Music Review* on body-instrument-technology, titled 'Inside-Out Instrument' (Harris, 2006).

These ideas and projects led to the works that form the basis for the concept of *Scorescapes*. With the desire to investigate more intimately and thoroughly the relationships between technology and environment, I began research into historical, contemporary and animal

technologies of navigation, particularly through sound. The graphic nature of the score returned in my interrogation of mapping and strategies of interpretation in mapping the land through sound, image and new technologies. My multi-media sound and video projects *Taking Soundings* (2006-7), developed at the Academy of Media Arts in Cologne, and *Sun Run Sun: On Sonic Navigations* (2008-9) developed at the Netherlands Media Art Institute and STEIM in Amsterdam, create embodied experiences that relate a cognition or consciousness of space and environment to an abstracted version of that environment through sound. These works question how we create and share knowledge of environmental locations through abstractions such as maps and technologies of navigation, and how these meanings can be built up mainly from embodied interactions in space (Harris, 2007a and 2007b; Harris and Dekker, 2009). These projects filled me with a personal need to explore and articulate this relationship between environment, sound and score in more detail, forming the basis for this dissertation.

2.4 Scorescapes: Sound and Place

The '-scape' in Scorescapes comes from landscape and seascape, emphasising historical continuity with 19th century painting and Land Art beginning in the 1960s. It is also a reference to the 'soundscape', a term that is most commonly associated with the Schafer, his publication *The Tuning of the World* (1977), and the related Acoustic Ecology movement, all dealing with various aspects of environmental sounds. Schafer's notion of the soundscape refers to the sound environment in a distinct location, which is considered in terms of relationships between interlocking systems that form an overall sonic context. Building on the visual discourse of Land Art and the sonic discourse of Acoustic Ecology, Scorescapes presents not the material itself (sound or land) but the underlying relationships between interacting systems.

The search for a coherent relationship to environment can be found in sound art and media art dealing with landscape and new technologies, such as locative media and eco-aesthetics and other practices (as discussed in chapter three). Among the various interpretations of environment, walking, mapping and forms of navigation and way-finding, are recurrent. These build on the idea that a fundamental way of engaging with place and actively understanding our movement through environments is by conceptualising them as maps and journeys. This is more than just a functional relationship to environment, more than getting from A to B, rather, it rests on an embodied understanding of how one moves and how one decides the

way, creating physical journeys that can be re-told, followed and notated. The map itself is abstracted from the land, much like the musical score is from the sound it denotes, but comes alive literally in the embodied process of interpretation. Likewise, sound embeds us within an environment by giving aural information about the context we are moving through.

2.5 Scorescapes in the Mind

Pauline Oliveros has developed practices and techniques of meditative processes that occur in music making particularly through expanded listening and improvisation. She is arguably one the most important living composers connecting musical practice and the contemplative condition in a profound way. What she calls "Deep Listening", begun in 1991, is a growing series of techniques and compositions involving an international community of musicians, therapists, teachers and artists. In her week-long Deep Listening Retreats, listening and walking meditations are combined with non-verbal time, dream practices, body movement, and group improvisation. By concentrating on fundamental processes that underlie music making her work seeks an expanded awareness of our connection to the environment and each other through sound, teaching and community. Known as one of the foremost electronic music pioneers, Oliveros combines these non-technological techniques with the latest forms of technology, most recently involving distributed social networking, including platforms such as Skype and Facebook, to expand the communities and create continuity between the intense retreat periods. Her work attempts to allow participants (no longer divided as composer, audience and performer but integrated as hybrids of all three) to reach a form of presentness, even over global distances, through sound. Such work emphasizes connectedness and group communication over distance through sound and exemplifies, in an expanded form, the idea of the role of a score(scape) as facilitating relationship.

Alvin Lucier's work can be interpreted as a score based on relationships, by revealing the workings of sound, in the mind and its environment. His work often makes the inaudible audible (and at times visual) in space while emphasising a notion of psycho-acoustics, whereby the music takes places within the mind and perception of performer and audience (Lucier, 1995; 152). As such, Lucier is an unusual example of fluidity between audification, sonification and visualisation. In *Music for Solo Performer: for enormously amplified brain waves and percussion* (1965) EEG electrodes on the performer's head translate sub-sonic alpha waves (8 to 12 hertz) into electrical signals which are amplified. These are made audible by using the loudspeakers to physically activate percussion instruments placed throughout the

space. This early piece combines audification of inaudible existing signals (the alpha waves produced by Lucier live on stage transduced into electrical waves that power loud-speakers) and sonification of those signals into sounds through the physical activation of percussion instruments by the moving speaker cone. At the same time *Music for Solo Performer* is a visualisation of the process as we see Lucier in a meditative state needed to produce alpha waves, the cones of the speakers, and the percussion instruments moving, we connect the three elements visually as well as sonically. Interestingly, the more alpha waves are produced, the more sound is created, which must directly feed back to the performer who may hear it but must not be distracted by it as this would bring him out of the alpha state. The performer is paradoxically active in an inactive state and his relationship to the sound itself is as one part of a larger feedback system. This piece has complex layers of process, transformation, listening and performance embedded into it through multiple feedback loops, and takes us through audible and inaudible states of sound and mental activity. The work is a sonic externalisation of internal listening, building what we might call a complex interconnected Scorescape.

2.6 Scores, Mapping and Navigation in my work

The exhibition entitled 'Possibility of Action: the Life of the Score' at the MACBA (Museum of Contemporary Art in Barcelona), sought to "document a revolutionary change in the way we notate and transmit music, from early graphic scores by composers such as John Cage, Christian Wolff and Morton Feldman, to intermedia experimentation and contemporary sound art" (Held and Subira, 2008: 4). It contained a wide variety of notations, scores, videos, electronics, clothing and interactive software. It included work from the 1960s to the present by composers as diverse Cage, Ashley, Behrman, Oliveros, Lockwood, Tenney, Cardew, Niblock and many more. My own work *Taking Soundings* (2007-8), named after a technique of determining the depth of the sea-bed beneath a boat by lead and line, was exhibited in this context. It traced navigations I made on coastlines around the world by satellite GPS, redrawn digitally in audio-visual performances, resulting in three chart sized prints and a sound work of environmental sound recordings and sonified GPS data (Harris, 2007a and 2007b). As I wrote for the catalogue:

> These images exist on the edge between a score and a map, line and sound, an event and a recording. Produced from satellite data collected by GPS of travels at sea and along coastlines, the work is "taking soundings" of position and movement. These

> images are the result of re-drawing those traces during a performance; as each part of the line is digitally drawn the data is transformed simultaneously into electronic sounds. The score then is being re-created, re-drawn, and so re-interpreted at the moment the sound comes into existence. These static prints become a record of a personal map, the memory of a shared performance, and encourage new interpretations by audience and viewer. (Harris, in Held and Subira, 2008: 14).

As evidence of this deep connection between music and mapping, *Taking Soundings* was re-exhibited in the 2010-11 travelling exhibition 'Ground Level' curated by Kit Hammonds for Hayward Touring and the Southbank Centre in London. In addition, Hammonds selected my video installation *Navigating by Circles, or Sextant*, which combines the view through the eyepiece of a sextant onboard a boat, with sonified GPS data. Both these pieces use a combination of moving image and sound to emphasise the negotiation through technology that is necessary to understand and calculate our position in a constantly shifting environment. In his catalogue essay 'Beating the Bounds', Hammonds outlines his rationale for exhibiting works that present a form of map-making that is experiential and physically "on the ground" rather than exclusively mapping from a bird's eye view. He writes,

> Ground Level brings together works of art that use forms of mapping to consider how we make sense of the world, how we belong to a place and to a people, and how we connect to the land we inhabit through negotiation, experience, memory and technology. The artists in the exhibition enact forms of research on the ground that echo the processes used by cartographers to draw up the land on charts, maps and legends. Rather than putting forward definitive surveys, however, the works presented open up alternative readings of the landscape, blurring the boundaries between here and there, us and them, me and you. (Hammonds, 2010: 6)

The ground level perspective is an involved, embodied experience of place and mapping, in which one experiences an intimate knowledge of the environment one moves through, contextualised as experience rather than as objective instructions. It recognises a personal relation to environment that is continually made and remade with every movement and orientation, as a way of making sense of the world one moves through and inhabits. The parallels with the score are evident in this approach, but only if the score is rethought not as a "definitive survey", or fixed musical text, but as personal alternative readings of the musical concepts as experienced and interpreted by composers, performers and audience.

2.7 Scores and Relational Aesthetics

The opening up of the role of music to encourage participation, aiming to influence and critique social situations, is reflected in the concept of relational aesthetics in contemporary art. Curator Nicolas Bourriaud articulates the emergence of art that works not with objects but with the relationships between social groups that contest the institutional frame of contemporary art (Bourriaud, 1998/2002). Sound art and media art have however been dealing with these issues for a number of years. LaBelle, who makes the argument for sound's inherent relational quality, which has manifested itself in sound art over the last thirty years and increasingly through digital technologies, states that "while insightfully recognising current trends within contemporary art, it seems also important to supplement Bourriaud's relational viewpoint with the legacy of sound art, which seems sorely lacking in his perspective" (LaBelle, 2007: 249).

The disciplinary distinctions between contemporary art, sound art and media art were bridged by the exhibition 'Playing the City' at Schirn Kunsthalle Frankfurt, curated by Matthias Ulrich in 2009-10. On seventeen consecutive days, several interventions and situations occurred throughout the city of Frankfurt that stimulated the social relations with public space, enticing the audience to a direct involvement with environment and social context. Ulrich writes:

> the viewer plays a part in the production of art works and the traditional roles of artist as producer and audience as recipients have largely been dissolved. This has brought forth a variety of forms of interactive, cooperative and interdisciplinary methods that, however, defy a precise classification (Ulrich, 2009).

Citing Bourriaud's theory of relational aesthetics, he argues that the works in 'Playing the City' "offer new forms of communication to the recipients of art, hence relational art acts as an antidote to social alienation" (Ulrich, 2009).

My project *Sun Run Sun: Satellite Sounders* (2008-9) was selected as part of Ulrich's exhibition project. *Sun Run Sun* investigated sonic navigations, furthering my earlier work on satellite GPS navigations, by turning the data from satellites into sound in real time. The *Satellite Sounders* were a series of hand-held instruments that I custom-built to sonify the movements of the satellites as they came in and out of focus orbiting overhead, listened to on headphones while walking. The experience of the walks that I instigated and led with members of the public, allowed them to walk off by themselves through the city while listening to their connection to orbiting satellites. The contrast in scale combined with the

revealing of the technological process through the use of sound composition, produced an experience that many participants described as completely shifting their perspectives. Akin to Oliveros' concept of Deep Listening, their active involvement in the work, and the personal experiences that resulted, help realign ideas of audience, performer and composer into a more collaborative and balanced relationship. If there is a score embedded in a work like this, it is not simply to be found in the musical 'text' of digital code and sonifications, but in the way the work invites people to act, to navigate and to explore their own relationship to environment through sound and movement, from a new perspective (for a more detailed description of this work see chapter four and the interview "Aiming for Dead Reckoning" (Harris and Dekker, 2008).

2.8 Scorescapes and Composition as Research

By understanding sound and navigation in combination, I arrive at an idea of artistic practice that is embodied, practical and poetic, and which places the participant in the centre of an active experience. This approach literally turns inside-out a conventional concept of musical composition, and this inevitably requires a re-thinking of the phenomenon of the score. Rather than learning to listen in order to organise sounds into final compositions, this approach asks us to use the process of composition in order to learn new ways of listening to sound. Dunn describes this method as inherently unfamiliar to the trained composer, as it generates an argument for musical activity and composition as learning to listen (personal conversation, 2009). It comprises a field in which sound enables a focused presentness that links the internal and the external, joining the individual human consciousness with a larger field of consciousness that is not anthropocentric. Along these lines, La Monte Young realized that "sounds and all other things … were just as important as human beings and that if we could … give ourselves up to them … we enjoyed the possibility of learning something new…." Composition itself becomes a research method. This resonates with LaBelle's comment that "Composition becomes a form of research conveying cartographic routes in and through relations to place." (LaBelle, 2008: 198). Scorescapes facilitates and instantiates this notion of composition.

3. Scape: Investigating the Environment through Sound

3.1 Rethinking Land Art and Acoustic Ecology

The multiple, conceptual and embodied ways in which we understand and relate to architectural and natural environments have been extensively explored by artists and composers over the last forty years. The current environmental predicament of climate change and sustainability, marked by the Kyoto Protocol agreement of 1997, and the UN Climate Summit in Copenhagen in 2009, make these explorations by artists ever more pertinent as they suggest alternative imaginations and practices for radically rethinking the ongoing challenge of relating to the environment, beyond the so-called 'green-washing' of current social politics. The rhetoric of climate change emphasises the dramatic pressure demanded to effect substantial global change in a short time frame, where the future must always be considered in the mind of the present. Historical perspectives and attempts to assess the situation are commonly neglected in this rush forward. The following discussion examines various artistic approaches to the environment, focusing on practices associated with Land Art and Acoustic Ecology, with special attention to composers R. Murray Schafer, David Dunn, and Hildegard Westerkamp, art historians Jack Burnham and Lucy Lippard, and cybernetician Gregory Bateson. This context frames my own research on sound and the environment.

Important historical precedents for current artistic practices involving environment can be traced to Land Art and Acoustic Ecology in the 1960s and 70s. The Land Art movement assessed the relationship between visual art and the environment by moving outside the gallery using the environment itself as material. Key examples include Robert Smithson's *Spiral Jetty* (1970) and Helen and Newton Harrison's *Lagoon Cycle* (1974-84). These works didn't just add sculptural forms to wilderness spaces, but used natural processes to engage in forming and questioning human relationships to environment. Around the same time the Acoustic Ecology movement was developing with Schafer publishing his now influential book *The Soundscape: Our Sonic Environment and the Tuning of the World* (Schafer, 1993, republished after *The Tuning of the World* (1977)). The aim was to bring more widespread attention to the sonic environment through study, experiments, mapping and teaching. By creating greater awareness of our relationship to these many sounds and their relationship to each other, Acoustic Ecology sought to heighten a sense of shared human responsibility for maintaining a sustainable balance in the environmental soundscape, and thus in the

environment in general. In what ways have these movements from forty years ago been rethought in terms relevant to today?

The last decade has seen a resurgence of interest in land and environmental art from the 1970s, particularly the work of artists such as Richard Long, Robert Smithson, Hans Haacke, Walter de Maria, Nancy Holt, Helen and Newton Harrison, James Turrell, Agnes Denes and others, that was somewhat neglected in the intervening decades. In the 1998 survey *Land and Environmental Art*, art historian Brian Wallis contrasted the marginal experimental attempts of a handful of artists in the 60s and 70s, with the global scale of the highly politicised United Nations Earth Summit of 1992 in Rio de Janeiro. In doing so he highlights the ironic neglect of Land Art in the 80s and 90s, that although "flamboyantly boostered in the heady, back-to-the-earth 1960s, has since largely fallen off the map of canonical art histories" (Wallis, 1998: 23). More recent attempts to address this gap include art historians Maja and Reuben Fowkes' essay 'Planetary Forecast: The Roots of Sustainability in the Radical Art of the 1970s' in which they note a neglect of the implications offered by environmental work of that time. "It turns out that many of the issues identified by theorists of sustainability …" they write, "were explored in the radical art of the early 1970s, only to be ignored in subsequent decades. These prophetic art texts are now ripe for rediscovery in the context of current attempts to grapple with the social and ecological consequences" (Fowkes, 2009). Although the publication in 1983 of Lippard's vital text, *Overlay: Contemporary Art and the Art of Prehistory,* suggests ongoing scholarly concern with these issues, the claims of Wallis and Fowkes, if overstated, nonetheless identify a diminished interest in the field.

Likewise, the work of Acoustic Ecology is being rediscovered and reinvented after a period of relative obscurity. Historian Kendall Wrightson in his paper, 'An Introduction to Acoustic Ecology,' describes the problem: "Like many issues emerging from the explosion of ideologies in the late 1960s, the profundity of Schafer's message is now hidden behind a single, soundbite-friendly issue: noise pollution" (Wrightson, 2000). Indeed, LaBelle claims that Acoustic Ecology confuses the concept of noise with noise-pollution, generating negative associations that imply a moral system of thinking about sound. He further argues that "acoustic ecology runs the risk of shutting down auditory possibilities by registering sound within an overarching framework of value: what sound is harmful and what sound isn't? Which sounds contribute to noise pollution and which sounds don't?" (LaBelle, 2007: xv). While this is a valid critique, it is these very social and moral implications that are being explored in much current work growing out of the traditions of Land Art and Acoustic

Ecology. Rather than being dismissed or ignored as a marginal environmentalist's niche and historical period, composers like Dunn work to define the ideas of sound and environment with greater relevance to the present, contributing to scientific knowledge and impacting upon public policy, while in the process of conducting artistic research.

In a recent essay entitled 'Acoustic Ecology and the Experimental Music Tradition' Dunn clarifies his relationship to Acoustic Ecology. In contrast to the limited 'soundbite' notion of the field (noise-pollution), he describes it as "a much more expansive domain of intellectual activity than would have ever been claimed by its original practitioners" (Dunn, 2008). He extends Schafer's work on defining listening and the soundscape as the social and didactic aim of the original Acoustic Ecology group, advocating a more open-ended interest in "the concern for achieving a deeper understanding of how sound and our sensory modality of hearing are unique organizing forces within human society, and our physical/ecological environment". He sees this concern as not exclusive to Acoustic Ecology, but also central to American experimental composers including Cage, Lockwood, Lucier, Max Neuhaus, Oliveros, Tenney, David Tudor and La Monte Young. He describes the new generations of artists and composers in the 2000s that show affinity with these backgrounds as "soundscape recordists, noise composers, installation sound artists, phonographers, microphonists, audificationists, and sonification researchers", and includes my own work on sonic navigations in a list of "diverse practitioners".

3.2 Systems Aesthetics and Direct Involvement with Environment: Burnham, Bateson, Dunn, Schafer

One of the most traditional ideas of ecology is based on interlinking natural systems and the mutual dependence of life within these systems. An ecosystem is based on balances within the complex parts that dynamically change in response to one another. The development of systems theory and cybernetics in the mid twentieth century theorised such structures of information within systems across many disciplines, from sociology and economics to science and the arts. More recently this has developed into ideas of complexity theory and emergent properties that develop from these dynamic systems. It is beyond the scope of this dissertation to explain systems theory in detail. For current purposes, it suffices to say that the relationship of systems theory to ecology and environmental research, especially with respect to the arts, has a significant history that is being reinvigorated by current practices.

The basic principle is one of interconnected complex systems that affect the development of one another, where a change in one part of the system will have effect throughout the whole. A crucial notion is that of positive and negative feedback loops within these systems, which move the system out of stable balance towards growth or destruction. Systemic relationships and feedback can be heard throughout the development of electronic music and seen in some visual art related to ecology. For example, German-American artist Hans Haacke's *Rhine Water Purification Plant* (1972) used systemic processes within a gallery setting, vividly illustrating these systemic processes in early environmental art. The installation consisted of glass bottles with dark polluted water from the nearby Rhine river that was passed through various purification processes in the gallery space, moving finally as clear water to a large glass tank with live goldfish, and ending with an overflow pipe through the window into the garden and joining the ground water level.

American art critic and curator Jack Burnham was at the forefront of forming ideas of what he termed 'systems aesthetics' in relation to emerging ideas of art and technology (Burnham, 1968). Although influential in the art and technology discourses of the late 1960s and early 1970s, systems aesthetics suffered neglect similar to that of Land Art and Acoustic Ecology but began resurfacing in contemporary art discourses in the 1990s and 2000s (Shanken, 2010). Art historian Marga Bijvoet gives an extensive account of the relationships between art and technology, environmental art and systems aesthetics in her book *Art as Inquiry* (Bijvoet, 1997), proving it to be particularly relevant to ideas of art, environment, and sustainability. Burnham applies a systems theoretical approach in his writing on Helen and Newton Harrison's environmentally engaged artwork:

> One of the basic principles of Nature is concerned with asymmetries that develop between bordering ecological subsystems. Given two bordering subsystems (either natural or cultural or a mixture of both), the less-organised sub-system releases energy to the more-organised, and in the process the less-organised sub-system loses information while the more-organised gains some. Over a period of time this produces imbalances between neighbouring ecosystems precipitating crises within the more-organised system. As a culture builds up its urban areas, mechanises and simplifies its food chains, cuts down its diversity of relations with Nature, it assumes the form of a more organised ecosystem drawing on the surpluses of energy from the simpler ecosystems around it (Burnham, 1973: 256).

As Burnham explains, the Harrisons observe that working with the interacting environmental systems in creation of a functional ecology (e.g. their *Lagoon Cycle* project

with crab and fish farms) inevitably influences the artists themselves and their relationship to their work. “Being drawn into an integral, on-going, natural system gradually alters the artist’s attitude towards self and the world.” (Burnham, 1973: 256). This observation emphasizes the integration of the artists as part of the environmental system itself and not as outside observers.

The basic tenet of Acoustic Ecology, as well as some bio-acoustic science, relies on ideas of interacting systemic balances between sounds in an environment. Schafer’s work on Acoustic Ecology can equally be described in these terms, as an elaborate unravelling of systemic interactions between sonic events that together make up the soundscape. Schafer’s account of the activities of a fishing community in Brittany, France, demonstrates how his conception integrates sound, weather and other environmental factors.

> Lesconil is surrounded on three sides by the sea and is subject to an onshore-offshore wind cycle known as "les vents solaires". Distant sounds are carried to the village in a clockwise sequence, beginning from the north at night, moving to the east and south during the day, and finally to the west in the evening. In the early morning, when the fishermen put out to sea, the Plobannalec church bells and nearby farming noises are heard clearly. By 9 a.m. it is the bells of Loctudy to the northeast; by 11 a.m. the "puffer" buoys off the east coast; then by noon, the motors of the trawlers out to sea at the south. (On a calm day they can be heard up to 12 kilometres away.) By 2 p.m. the western buoys are clearly heard, and by 4 p.m. it is often possible to hear the blowhole at Point de la Torche, 12 kilometres away to the west. If the weather is foggy, the afternoon will bring the sound of the great foghorn at Eckmühl, on the same coast. By evening the farm sounds return and with them the bells of Treffiagat to the northwest. This pattern is characteristic mainly of the summer months when the weather is clear and the fishing good. Variations in it indicate weather changes: for instance, when certain buoys are heard out of sequence, there will be a squall; or when the surf is strong in the west, good weather will follow. Every fisherman and every fisherman's wife knows how to read the nuances of these acoustic signals and the life of the community is regulated by them. (Schafer, 1977: 215-6)

Creating such an awareness of the systemic interrelatedness of environmental factors with human perception and activity is central to the principles of Acoustic Ecology and provides a shared foundation for ongoing research currently conducted by many sound and visual artists. For example, the work of Lucier lends itself to interpretation in terms of systems and systemic relationships between sound, perception, and environment. Lucier often sets up a

system or a set of procedures by which loops occur, as in for example *Music for Solo Performer*, , *I am Sitting in a Room* or *Quasimodo* (discussed in more detail in chapter five). This systemic awareness of sound extends as well into scientific research. In bio-acoustics, for example, it is often the interaction between sonic elements of biotic, abiotic and anthropogenic sounds that are analysed, providing clues to the health or imbalance of an ecosystem through acoustic analysis (discussed in chapters four and five).

Dunn explicitly refers to cybernetics and systems theory as important influences on his work as a composer, specifically identifying anthropologist and cybernetician Gregory Bateson as well as more contemporary complexity theories especially related to ecology (a discussion of Dunn's work on bark beetles in relation to complex systems is discussed in chapter four). Bateson's book *Steps to an Ecology of Mind* (1972) was widely read and discussed by artists. In it, he calls for a change in attitude towards the natural world, away from human dominance and an outside perspective, to one integrated within the system itself. In his lecture 'The Roots of the Ecological Crisis', he identified the basic causes as lying "in the combined action of (a) technological advance; (b) population increase; and (c) conventional (but wrong) ideas about the nature of man and his relation to the environment" (Bateson, 1972: 488-93). Dunn is informed by Bateson's ecological systems theory ideas, in particular the notion of "mind in nature" which considers "mind" to be larger than the individual, embedded in the ecological systems themselves. The composer's work from the 1980s to the present engages with the problem of complexities between systems of non-human and human worlds and envisions a possible re-shifting of balance away from human dominance, for example in his recordings of underwater sound used in *Chaos and the Emergent Mind of the Pond* (1991). In Dunn's view, this shift embraces technological advances as a part of the complex evolutionary system.

> The issue that confronts us is that the living systems making up the homeostatic complexity of the biosphere are reorganising as a consequence of human influence. All natural systems will do this given sufficient perturbation and disequilibrium. We have been a part of that natural process. The question remains: Will it reorganize in a manner that includes or excludes us from its larger complexity? In our attempts to grapple with this question, we cannot easily abandon the technologies that have contributed to the disequilibrium. I believe we can transform their use into tools to remind us of the larger systemic complexity within which we reside. (Dunn, 1988)

3.3 From Prehistory to Eco-Aesthetics: Lippard and Dunn

The artistic exploration of relationships to environment has a long history, even a prehistory and important parallels can be drawn between the visionary work of Lippard on recontextualising Land Art and Dunn on recontextualising Acoustic Ecology. In her book *Overlay: Contemporary Art and the Art of Prehistory*, Lippard conceptually 'overlays' environmental art from the 1970s onto prehistoric art, in particular the land-based stone circles and burial mounds found throughout North West Europe and North America (Lippard, 1983). In doing so she generates a dramatically broader context in which to theorise the challenging questions set out by Land Art. Rather than to suggest a nostalgic return to a distant period, she uses this overlay of two vastly different historical and cultural periods to refresh the relevance of articulating the relationship to environment by artistic means. She argues that late twentieth century artists' interests in land and environment, echoing an embedded social function of prehistoric art and ritual, lead towards the opening up of the art-world, and artists roles within it, to social activism. By moving outside of the usual, urban realm of art and gallery, the performances and sculptural interventions in the environment, as described in her book, offer experiences that reinvigorate the question of humanity's ongoing, changing relationship to the environmental context of which it is a part.

Lippard argues against a simplistic romantic interpretation of this interest in environment, instead presenting it as a down-to-earth compulsion towards investigating the relationships between the natural and cultural worlds through aesthetic means.

> Speculation about the close relationship between nature and culture in prehistory is not starry-eyed idealization, nor is it ahistorical fantasizing about a Golden Age. People living between earth and sky, with few human-made distractions, had to be far closer to natural forces and phenomena than people living on our crowded planet now. They were undoubtedly aware of their environment in ways lost to us. Obviously we do not relate to nature in the same way, but the reestablishment of a coherent relationship between nature and culture is a critical element in any progressive view of the future. (Lippard, 1983: 12)

There are significant parallels between Lippard and Dunn. Where Lippard's insights into the relationship between prehistory and contemporary art – specifically Land Art from the 1970s - lead to her claim that "the reestablishment of a coherent relationship between nature and culture is a critical element in any progressive view of the future" (Lippard, 1983: 12), Dunn makes a similar move in his theories of the development of music. He places

work from the Acoustic Ecology and the Experimental Music traditions from the 1970s, within the context of recent prehistoric theories of sound and music. Drawing on paleo-anthropologist Steven Mithen's book *The Singing Neanderthal,* which posits a common prehistoric root between music and language in an early communication system he refers to as Hmmmmm communication – Holistic, manipulative, multi-modal, musical and mimetic (Mithen, 2006). Dunn suggests that this co-evolution of music and language has vast implications:

> In the light of insights inherited from the experimental music tradition and the broader meaning for Acoustic Ecology previously outlined, I am willing to contend that this capacity to hear the soundscape as music is simultaneously one of the most archaic ways of listening and the most modern. Music is both a conserving action for keeping alive a mode of communication similar to non-human forms of cognition and an intuition to a future communication modality that we are actively evolving. (Dunn, 2008)

Dunn's interest in the relationship between understanding the soundscape and musical development as an evolutionary process and necessity is highly distinctive. His position suggests a validation for detailed research into our relationship to the environment through sound, not simply as a relationship to music but in its social, political and scientific potential. In doing so he broadens the expectations and scope within which music can act:

> I also believe that awareness of the historical moment—signalled through extensive loss of biological diversity, global climate change, and the impacts of human over-population—will demand an even further shift in how the sonic arts move beyond purely expressive concerns, or documentary and sensory heightening strategies alone, towards participation in both scientific research and subsequent interventions in growing environmental dilemmas. This is just another stage in how music has always congruently evolved with human needs. (Dunn, 2008)

Dunn's vision of the composer's potential transdisciplinary role as a researcher working at the intersections of science, art and environment, can be seen in contemporary developments of environmental art and sound art. The present interest in environment is reflected in the rise of 'eco-aesthetics', 'eco-art' or 'environmental aesthetics' in recent years. Seen in a number of exhibitions, often using the same name, including *Weather Report: Art and Climate Change* curated by Lippard (Lippard, 2007), and *Ecomedia: Ecological Media in Today's Art* (Himmelsbach and Volkart, 2007), eco-aesthetics shows the emergence of a

contemporary interest in relating to environment in ways that include technological visualisations and sonifications of complex data, and social actions revealing environmental processes. Much of this work tends towards an overtly didactic emphasis. For example, some works seek to create awareness and educate the public about their role in sustainable living, echoing the educational priorities of Acoustic Ecology. Other work relates more to the aesthetic traditions of Land Art. In general eco-aesthetics illustrates a tendency of environmental art to move towards social engagement, as posited by Lippard in *Overlay*, and reinforced by LaBelle's notion of sound as relational.

My own work has been exhibited and performed in the contexts of eco-aesthetics, acoustic ecology, video installation, and sound art. It is often illuminating to observe how the same work is interpreted differently in various visual art and musical traditions stemming from Land Art and Acoustic Ecology. This is not only characteristic of the nature of artwork that crosses disciplines, but also illustrates the interest of these disciplines to broaden their scope, overlapping topics that may previously have been dismissed as belonging to the other camp. I lectured on my work 'Taking Soundings: A Composers Investigation into Technologies of Navigation' at the international conference Mutamorphosis: on Art and Science in Extreme Environments, in Prague in 2007. In this context, I was part of the Eco-Sonifications panel, alongside Dunn and James Crutchfield and environmental sound artist Andrea Polli. The following year *Sun Run Sun: on Sonic Navigations* was presented in the visual art exhibition Eco-Aesthetics curated by Hicham Khalidi at TAG in Den Haag 2008. This show included visualisation work by eco-artists and designers Tiffany Holmes, Beatriz de Costa and Michael Mandiberg. My sound and video performance *Fishing for Sound*, which explores underwater sound in relation to sonified satellite data from space and sound in the mind, was programmed at the festival, Sonic Acts XIII: The Poetics of Space, in Amsterdam in 2010 as part of the Acoustic Spaces session alongside work by Hildegard Westerkamp and Barry Truax from the original Acoustic Ecology group, and Annea Lockwood. The same piece was programmed later that year at the Ear to the Earth Festival organised by the Electronic Music Foundation in New York City with other artists dealing with sound and water such as Lockwood, Polli and David Rothenberg. These are some of the very varied contexts within which my work has been framed, illustrating the overlapping areas of interdisciplinary work stemming from Land Art and Acoustic Ecology.

3.4 Walking as Active Engagement with Environment

Both Land Art and Acoustic Ecology share a key technique that continues to be influential: walking as a material and as an art form. Walking, as an artistic medium, has been theorised as an action that relates one to the space being moved through. Writer Rebecca Solnit, in her book *Wanderlust: A History of Walking* (Solnit, 2001) traces the history of walking as a cultural act embedded in literature, philosophy, art, religion, environment and politics. She considers how walking relates to the body and thought, the city and country through the historical emergence of walking as a consequence of less dangerous cities, and gender issues of safety, leisure and historical convention. It is also a history of people breaking with convention and stepping out, often literally, to make a point, to act out dreams, to resolve or prove. Solnit mixes very personal accounts of actual walking experiences with examples drawn from a wide variety of sources. She ends with a wonderful personal reflection of a walking exploration of Las Vegas and the Nevada Desert, as a site of contemporary walking culture being revitalized in new (warped) forms in the least expected place. She describes the active relationship built up between walker and environment in these terms:

> Walking has been one of the constellations in the starry sky of human culture, a constellation whose three stars are the body, the imagination, and the wide-open world, and though all three exist independently, it is the lines drawn between them – drawn by the act of walking for cultural purposes – that makes them a constellation. Constellations are not natural phenomena but cultural impositions; the lines drawn between stars are like paths worn by the imagination of those who have gone before. This constellation called walking has a history, the history trod out by all those poets and philosophers and insurrectionaries, by jaywalkers, street walkers, pilgrims, tourists, hikers, mountaineers, but whether it has a future depends on whether those connecting paths are travelled still. (Solnit, 2001: 291)

The "constellation" of body-imagination-world is an experiential, first-person relationship to environment generated by walking through it. Presented in so many forms by land artist Richard Long, but perhaps most emblematically in his *A Line Made by Walking* (1967), this constellation is also a key to the 'sound walks' of Schafer and other sound artists. Hildegard Westerkamp, Janet Cardiff, and Christina Kubisch for example, have developed the walking as an artform in different ways. Westerkamp, who joined Schafer's World Soundscape Project in the early 1970s, takes groups on listening walks with no technological aid. Cardiff, whose sound walks gained attention in visual art circles in the mid-1990s, creates pre-recorded scripts that provide a narrative for a journey taken by walkers, who listen to the

recording on headphones. Kubisch, a trained composer whose first sound installations date to the 1980s, gained recognition in the 2000s in media art circles for her *Electrical Walks* that detect electromagnetic interferences in the environment (e.g., transformers, wireless devices, antitheft and surveillance equipment) and translate them into audible range that users can listen to on special headphone instruments.

I am interested in the different approaches of both non-technological and technological sound walks, like those of Westerkamp and Kubisch, as both encourage different relationships to environment through walking. In a lecture at the Sonic Acts Festival in Amsterdam 2010, Westerkamp talked about the diversity of her sound walk practice. Most walks consist of a group with a pre-determined leader who has planned and mapped out the route of the walk prior to the event itself. The group are led around already existing sound marks and changing soundscapes that are in a way composed by the group leader. Westerkamp described another walk however, where the group had no leader and no predetermined route. What emerged were moments of confusion, particularly at road junctions where choices of which direction to walk could split the group. As verbal communication is prohibited on these walks, negotiation could not take place by discussion. She described how the state of heightened awareness is produced by active listening. The group came to consensus as a whole, without argument or negotiation, in a way that she likened to migrating animals or birds. This kind of heightened bodily sensing and awareness of the group came through walking and listening.

The introduction of technology provokes a rather different constellation of body-imagination-world than walking without a technological extension. Solnit remarks, "… the sensing, breathing, living, moving body can be a primary experience of nature too: new technologies and spaces can bring about alienation from both body and space" (Solnit, 2001: 257). It is the usual concern that technologies effectively cause 'alienation from both body and space', for example the 'schizophonia' described by Schafer where the sound is split from its source. " Schizophonia … refers to the split between an original sound and its electroacousitc reproduction … I employ this 'nervous' word in order to dramatize the aberrational effect of this twentieth-century development." (Schafer, 1977: 273) But this very alienation can be challenged, and even used or played with, to provoke greater awareness of ones surroundings and body in environment.

Westerkamp concentrates on heightened listening to environmental sounds within the environment and group behaviours that develop out of this state of awareness when being guided predominantly by sound rather than sight. Cardiff, by contrast, uses the environment

as a setting for dramatic enactment of events to take place, where the actor, rather eerily, is oneself, literally walking in the shoes of the narrator whose voice is quite literally in one's head via the pre-recorded sound played back on headphones. Relation to the environment through sound is in this case shifted, altered, fractured somehow, causing a disturbance that provokes the imagination. Kubisch's *Electrical Walks* expand our listening capabilities to introduce us to sounds that are always present in our everyday environment, but that we cannot hear with the naked ear. The participants can explore these soundworlds, activating the constellation of body-imagination-world.

In my own work, walking as a means of embodied experience of movement in environment has featured prominently since *Walk for an Absent Public* (1995). I also have explored other forms of motion, such as sailing and swimming, related to the aqueous environment of the sea. For example, *Symphony no.2: Sargasso Sail across the Bermuda Triangle* (1997), which involved a week-long sail through this fabled location of countless ships lost at sea. These laid the foundation for further experiments with landscape and in particular the importance of interacting with technologies of navigation to find one's way and build meaning via movement through an environment. Rethinking walks in terms of a technological relationship to environment, I created *Taking Soundings* (2007-8) and *Sun Run Sun* (2008-9) (described in chapter four), key works in the evolution of *Scorescapes*, which explore historical, contemporary and animal navigations through sound. In terms of walking and the importance of navigation, these projects, which created GPS sonifications, maps, installations, performances and instruments, were contextualised in a variety of contemporary emerging practices. In the music and technology field I have presented these projects in the Mobile Music Workshop 2007 and 2008 (Tanaka et al, 2008) and NIME 2008 (New Instruments for Musical Expression conference), both of which are concerned with the influence of technology on musical instrument development. Most recently they have been theorised as challenging Locative Media practices, which use hand-held portable media such as GPS and mobile phone devices to create interactive situations in outdoor space, some of which generate affective bodily involvement in these spaces.

For example, curator Annet Dekker, who commissioned *Sun Run Sun*, theorises it in terms of changing awareness of one's environment through the embodied use of technology, in contrast to many locative media practices that use current mobile technologies which "evolve around an interest in new tools, and without questioning them, they are asserting the aesthetics of the consumer market and affirming the control society." Her analysis of the use of sound to create intuitive and embodied experiences in the participants taking the

walks with the *Satellite Sounders* illustrates these points.

> By using sound as a vehicle, Harris attempts to open the lesser- used space of aural experience. Sound has the ability to open up a subjective dimension in listeners, mitigating the coldness and mechanization of reading digitally generated data. SRS does not contain musical meaning or symbolic references, nor is it a usable navigation aid; it functions as a catalyst for subjective experience. Participants describe their walk as a heightened sense of embodied location, as a strong emotional-physical connection to locational technologies in the sky, and as a merging of intuitive and rational means of navigating the environment. Returning from a walk, one person said it made her feel small and insignificant, and that this was a revelation to her. People comment that they see and feel the world around them differently, as someone pointed out, "like being on drugs". Others experienced a transformation, with a contemplative sense of body and place temporarily blocking out the cares of an otherwise hectic urban lifestyle: "It's like being in a constant conversation with every aspect of my environment, reacting physically to everything around me". Using an intuitive navigator, *Sun Run Sun* provides people with new experiences not just of space but also of body and mind. Affect of place is constituted here through technology; its relation to the body in movement is what makes its affect felt. (Dekker, 2009: 3)

Media theorist Susana Zaragoza, discusses *Sun Run Sun* in the context of non-representational theory and knowledge gained through qualitative, embodied experience of place.

> In fact, a different sensitivity to one's immediate surroundings and one's position on Earth arises. These non-representational spaces are out of the realm of meaning and can only be experienced in their performance. A performative practice is necessary in order to understand this new logic of our current calculative world. (Zaragoza, 2010)

I have experimented with this process of hyper-aware listening while walking, implied by Westerkamp, Kubisch and my own *Satellite Sounders,* by taking the recording and its removal of context a step further. If I walk down the street I listen primarily to sounds that facilitate my movement and navigation of space, working in combination with the other senses. If I play a sound recording of that same walk back to myself in a quiet space I listen in a different way, without the need to process and interpret sounds immediately for action, motion and understanding of my environment. Because I am not physically active I am listening with

different criteria and necessity, and so the sounds have a different meaning. I may not even really recognise the recording as the place I have just walked. However, if I play that same recording back to myself while making the same walk, but of course at a different time, I am confronted by a disjunction between my listening and my environment. For example, I may recognise the road, but not see the car that I hear pass by me. I see someone walking towards me, but their footsteps are out of sync with the sound I am hearing.

Through this experiment of layering sound, I became consciously aware of my listening process and the function of hearing in orientation, movement, time and being in that place. These are my notes after trying out the walking piece for the first time at Orpheus Institute Ghent in January 2010 with five participants:

> Think also of the walking piece – recording sound just before and playing the same walk back in the same place but time-shifted. What does this do to us? Different reactions, of paranoia, of getting in sync, of play, of indifference, of out of balance, asynchronicity and surprise, of awareness of environment and our use of senses in its perception. Time, time folded, time collapsed upon itself, the same place different time, an extension of time, time past but overlap to time future through time present. Where is my sound in time present? Or am I listening to it and walking in the future? Do I loose my reference point, my temporality of 'now'?

In an analysis of this walking experiment, media theorist Marta Colpani interprets it in terms of perceptual functioning and shifts that generate an enhanced bodily awareness.

> From a theoretical perspective, the relevance of this piece is mainly in perturbing the interaction that takes place between *exteroception* in sound and vision, *proprioception*, and *interoception* in the perception of *suspense* generated by the sounds of absent events. This work makes the participant extremely aware of the functioning of his body when feeling and perceiving reality. The work therefore reflects on human perception, and in this case is strictly focused on the relation between space-time and the body. (Colpani, 2010)

These theoretical interpretations of my recent work corroborate my artistic attempts at using walking as a central element and extending this through sound and perception to create embodied, active experiences of environment.

4. Inaudible: Sounds beyond Human Hearing

4.1 Why Make the Inaudible Audible?

The question of making the inaudible audible to human perception is particularly important in the study of sound and the environment. It relies on the realisation and acceptance of the limitations of human hearing range. When I first presented these ideas at the Netherlands Royal Society for Musicology in 2009, a member of the audience objected by saying that the word 'sound' can only possibly be considered in relation to what humans hear, and that anything vibratory that lies beyond this human capacity cannot therefore be sound. But it would be absurd to say that a cat, when hearing a mouse squeaking at frequencies above what I can hear, is not dealing with sound. In this writing I hope to make it incontrovertible that such an anthropocentric attitude to sound is detrimental to both the environment as a whole, and to our human inhabitation within it. When I presented this work at ISEA (International Symposium for Electronic Arts) in 2010 as part of a panel entitled 'Sonic Stategies' (Harris, 2010), my investigations into making the inaudible audible generated significant discussions about audification, sonification and visualization.

In her book *The Soundscape of Modernity* historian Emily Thompson argues that since the industrial revolution the increase in anthropogenic sound in the environment has become a significant problem (Thompson, 2002). Other forms of life, animals, insects, birds, fish, and even plants have different ways of both hearing and using sound. Bio-acoustic research is continuously discovering new hearing and sounding mechanisms in non-human life-forms and their relationship to functioning and sustaining complex eco-systems. An imbalance in the sound ecology, for example when an excessively dominant sound is introduced from outside, can provoke or signal an imbalance in ecological systems (Schafer, 1977).

The implications of the study of sound and making the inaudible audible, quite radically demand that we actively rethink our position within other larger non-human ecologies. As discussed in the previous chapters, the work of Acoustic Ecology focuses on listening, to emphasize an awareness of the overall soundscape. However, this is usually limited to areas where it directly affects human presence on land. It is largely because, for example, ultrasonic and underwater sounds are inaudible to us, that we are generally unaware of the impact of anthropogenic over biotic and abiotic sounds. As will be seen in chapter five, acoustic levels underwater are largely unregulated, and given that sound is essential to

marine life, the impact of additional sounds is having considerable consequences on the ecological balance of the oceans.

It is therefore crucial that we research and actively understand sound that is otherwise inaudible to us. There are different approaches to making the inaudible audible as well as a confusion in terminology, so this chapter is an attempt to straighten out some basic principles and open up the possibilities. Scientists and composers, often limited to discipline-specific methodologies, are driven by different motivations and priorities in the analysis and use of sound. As a result approaches to making the inaudible audible generally fall into two camps of analytically strict systems or more intuitive translations. It raises the following questions: given that gathering, analyzing and disseminating sound beyond our hearing ranges is intimately bound up with technology and its development, to what extent do we question the "ostensible neutrality of these listening technologies" (Kahn, 1999: 200), given that listening is both personal and contextual (LaBelle, 2007)? When making the inaudible audible, what happens if we consider not simply what we hear, but how we listen? To assess these questions I will use examples from composers, scientists and other expert listeners.

4.2 How to make the Inaudible Audible: Visualisation, Audification and Sonification

Sounds can be inaudible or imperceptible to us in different ways. The basic parameters are sounds that lie out of our frequency range (in average human hearing, above 20,000 hz and below 20 hz), beyond our amplitude sensitivity (either too quiet or loud), and of a time frame that may be imperceptible to us (too fast or slow). To compare the scientific to musical terminologies: frequency/pitch, amplitude/volume, and time/rhythm or form. Sounds can also be inaudible to us because of the inaccessibility of them, of very large or small spatial scales, from the cosmic to the nano-scale, or extreme environments that are uninhabitable to humans such as underwater. Even when a sound is within our hearing range, whether we hear it or not depends largely on how we pay attention and the mental filters we impose on everyday listening. In this sense sounds can be inaudible because we are not attentive to them, and we may need to practice listening techniques in order to actually hear them. The central concern of making the audible inaudible is to practically research the potential ways in which these sounds can be folded into our relatively narrow perceptual bandwidth.

The most common strategy to understand inaudible sound is visualisation. In this case sound is represented graphically by depicting the parameters of frequency and amplitude over time,

usually called spectogram imaging. The analysis of humpback whale sounds for example (as discussed in detail in Whale chapter) demanded visualising the sound waves to reveal recognisable patterns, which Payne and McVay called 'songs', which are too slow to recognise by ear (Payne and McVay, 1971). This is the primary technique used by bio-acoustic researchers, to the extent that they will often look in more detail at the spectograms of sound, rather than listen to the sound itself. Schafer discusses the reliance on this technique of visualization: "I want the reader to remain alert to the fact that *all visual projections are arbitrary and fictitious*" (Schafer, 1977: 127, his italics). He continues:

> Today, many specialists engaged in sonic studies – acousticians, psychologists, audiologists, etc. – have no proficiency with sound in any dimension other than the visual. They merely read sound from sight. From my acquaintance with such specialists I am inclined to say that the first rule for getting into the sonics business has been to learn how to exchange an ear for an eye. Yet it is precisely these people who are placed in charge of planning the acoustic changes of the modern world (Schafer, 1977: 128).

During an initial research visit in July 2009 to the Laboratory for Applied BioAcoustics of the UPC (Polytechnic University of Catalunya) Barcelona /Vilanova, I observed a researcher who worked in a noisy environment in a fishing harbour, with windows open and the noise of computer fans. He used only his computer loudspeakers, and occasionally low quality headphones to listen to the sounds he was searching through, which I, sitting next to him, could barely hear. Despite my initial concern at this he explained to me that the visualisation allowed him to recognise patterns in the sound that would have been very difficult to hear and may have been missed in the progression over time. He was indeed a proficient sight-reader, which related to his deep understanding of the sounds he was listening to, but this was not achieved by concentrated listening itself.

Visualisation has become the major technique in analysis of complex data sets, but the development of audification and sonification techniques that use sound to describe sound or data, rather than sight and the visual, is comparatively new and undefined. I identify and distinguish between two overlapping approaches to making the inaudible audible: *audification* by scaling existing vibratory signals into human hearing range; and *sonification* by translating and mapping a choice of sounds onto data. Audification uses the existing signal as its basis, while sonification requires compositional strategies of mapping data (non-vibratory information) onto sounds. Confusingly, often examples of audification and sonification are used interchangably, but they are distinctly different treatments of sound, and the

relationship to the original media differs in that audification remains considerably closer than sonification. The interaction of visualisation with audification and even sonification can be very powerful for understanding inaudible sound.

4.3 Audification

The following examples by composers illustrate and raise important questions about techniques and distinctions between audification and sonification. Lucier's work can be said to be making the inaudible audible or at times visual in space (see the analysis of *Music for Solo Performer* in chapter two). Dunn works at the edges of human hearing, the environment, technologies and music. Some of his works are profound examples of the influence of audification beyond something to simply listen to. In *Listening To What I Cannot Hear* (2009), he lowers the overall frequency of ultrasonic recordings he has made, to make us audibly aware of sounds we create but cannot usually hear. This includes the sounds of: bats, chewing a carrot, crinkling aluminum foil, rattling a key chain and tree cavitation emissions. It is not only the variety of sounds that are interesting in this work, but the familiar quality of many of them. The piece is reminiscent of strange bird calls, bells and gongs being irregularly hit, continuous hums that we would associate with electrical appliances. In performance, Dunn hands out a program note with a timeline that details the timing of specific sounds. In doing so he specifically challenges us to link a sound to a source, even though what we hear may make us imagine something else. It is this relationship between what we hear, what we assume the sound to be from experience, and what we are told the actual source is, that highlights the complex relationship to inaudible sound.

Dunn's collaborative research with complexity physicist Crutchfield into the problem of infestation of bark beetles in North America grew out of experiments with audification of the beetles' sonic worlds. This groundbreaking environmental work highlights sound as the key to a series of feedback loops relating climate change to drought stressed trees to bark beetle infestation. By placing custom-made microphones in infested trees and amplifying the results, this example of audification has advanced scientific research, leaving Dunn and Crutchfield as the unusual experts amongst scientists in this field (Dunn and Crutchfield, 2009).

To consider sound as a primary feature in this complex system is an almost untried idea, as more common techniques to research insects have focused on chemical emissions. They discovered that not only do bark beetles produce sounds, but that drought stressed trees

also emit frequencies in mostly the ultrasonic range. It appears that the beetles respond to this signal and will infest a dying tree. Using a systems theoretical approach (Crutchfield was a student of Gregory Bateson and researches complex systems) they have analysed the problem as follows: as rising climate temperatures cause more drought, the trees are more likely to be infested by the beetle, dead and dying trees are more prone to forest fire, the carbon lack in dying forests, and the increase in carbon from burning trees impacts the rising climate temperatures. On top of this, the beetles can adapt more rapidly than the trees to rising temperatures, and are able to move into previously uninhabitable areas, increasing the amount of infested forest. These complex interrelated cycles are in effect spiralling out of control and some form of intervention is necessary. They propose a possible intervention using sound as a potential deterrent to the beetles, acoustically masking the cavitation emissions from trees, and preventing the beetles from spreading.

The success of this project came from the listening ideas of a composer, rather than a scientist, and a hands-on approach to experimental microphones, recordings and audifications. Dunn composed a collage of the sonic emissions of the bark beetles *The Sound of Light in Trees* (2006). Previous to these recordings, bark beetle specialists had not heard or minimally considered the sound of the beetle, and so could not imagine the implications of this study. The freedom of methodology of a composer over a scientist may be a significant reason. The project shows how far making the inaudible audible can reach in environmental work and sets a whole new precedent for research methodologies using sound beyond human hearing range.

Another recent project on audification is by artist and seismographic researcher Florian Dombois and his research group at Bern University of the Arts. In a statement on what he refers to as 'auditory seismology', the audification of seismographic data, he discusses the benefits of using sound over image to analyze certain properties of data. He states:

> Philosophical and psychological research results show that there is a substantial difference between seeing and hearing a data set, because both evolve and accentuate different aspects of a phenomenon. From philosophical point of view the eye is good for recognizing structure, surface and steadiness, whereas the ear is good for recognizing time, continuum, remembrance and expectation. In studying aspects like tectonic structure, surface deformation and regional seismic risk the visual modes of depiction are hard to surpass. But in questions of timely development, of characterization of a fault's continuum and of tension between past and expected

> events the acoustic mode of representation seems to be very suitable. (Dombois, 2011)

His observations seem relevant to both audification or sonification and indeed the distinction between the two is not always clear in the terminology used. His Sonification research group puts this theory into practice by either sonifying, or more likely audifying, the seismic data of the Japanese earthquake of March 2011. The data is made audible by an acceleration factor of 1440 times, and compressed in order to hear the main shock (sonifyer.org, 2011).

The question arises as to what methods are used to scale signals as these will have a direct impact on what we hear and what conclusions may be made as to the relationship between the source and the sound. The most predominant technique is to scale by a convenient factor, say by 10 (or 1440 in the case of the earthquake). This is convenient for the mathematics involved in scaling, and is usually used to place the scaled sound in the middle of our hearing range, what I call the 'sweet spot', the area that we use for speech and musical sound. The approach of scaling has a clear rationale, but in practice it means that very low sounds and very high sounds can become extremely close together, so a whale and a bat may sound very similar (something like a bird) after this kind of scaling. An alternative approach, one that is however never used, would be to choose a scaling factor relative to the way we listen, so that high remains high, and low remains low. This would draw upon psychological perception of sound, rather than ignoring this probable bias in our listening for a supposed scientifically neutral result.

4.4 Sonification

Techniques of sonification raise even more questions as to the relationship between the source and the sound one hears. Sonification means to translate and map a choice of sounds onto data. But how are these choices made and are there guidelines about how to achieve a good sonification? The term is used quite regularly but inconsistently, and it is hard to find descriptions of motivations as to why certain sounds were chosen over others.

In 1997 the ICAD (International Community for Auditory Display) published a report for the US National Science Foundation, on the status of the field of sonifcation, largely in response to the dramatic increase in data and the predominant mode of analysis through data visualisation. They state:

> sonification is defined as the use of nonspeech audio to convey information. More specifically, sonification is the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation. By its very nature, sonification is interdisciplinary, integrating concepts from human perception, acoustics, design, the arts, and engineering. (ICAD, 1997: 2)

This report gives an overview of the field at the time, including mentioning historical precedents such as the Geiger counter and sonar, and outlines future needs for development in perception, education and technology, to make sonifcation a useful, scientifically valid technique. They suggest the increasing complexity of sonification as a research field:

> research in auditory perception has progressed from the study of individual auditory dimensions, such as pitch, tempo, loudness, and localization, to the study of more complex phenomena, such as auditory streaming, dynamic sound perception, auditory attention, and multimodal displays. (ICAD, 1997: 2)

Alongside scientific work on sonification, as represented by the ICAD report mentioned above, musicians and sound artists have become increasingly involved in the processes of making data audible. Composer Charles Dodge created an early example of sonification in *Earth's Magnetic Field* (1970) by mapping the so-called Bartel's Diagrams of magnetic fields onto computer generated sounds (Dodge, 1970). More recently, sound artist Andrea Polli explicitly identifies her approach to sonification with the aesthetic / artistic domain of Acoustic Ecology. In a recent online interview Polli says "A large part of my work involves reshaping and reordering information using data sonification, and my sonification methods are influenced heavily by the historical and contemporary work and research of the international Acoustic Ecology community." The following excerpt from this same interview illustrates her concern with combining a data translation with perceptual, contextual and environmental ideas of soundscapes, as if thinking of natural sound as a model for sonifications. (Note the confusion between audification and sonification in the interviewer's question).

> ER. Can you explain the process of sonification or audification? I understand it as scientific data which has somehow been subjected to change.
> AP. Schafer talks about the 'sound object' defined by Pierre Schaeffer, the sound disconnected to the source, and Schafer is interested in re-establishing the ecological connection. When you look at the success of the Acoustic Ecology movement, it's

> clear that it is possible to re-establish that link, and I think that sonification of environmental data brings this to another dimension, although I think like data visualization, data sonification has shortcomings and it is important to always remember that it is an interpretation and also a simplification of the data. It's important also to remember that the numerical data itself is also a simplification; it's impossible to collect data on everything that is happening in an environment. The best we can do is go out into the world and experience it with the most sophisticated sensors that exist, our bodies (Polli, 2010).

4.5 *Sun Run Sun*: an example of compositional process of sonifcation

My own project *Sun Run Sun: on Sonic Navigations* (2008) explicitly explored this relationship between sonified data and our physical experience of environment. I researched historical, animal and contemporary technologies of navigation and questioned the relationship between the real world we understand through our senses and the cognitive process of relating this onto a visual or spatial map. By thinking of echolocation techniques of cetaceans and bats, which are the model for the far more primitive Sonar technology for testing the depth of the seabed and navigating underwater, the question arose how these animals comprehended their physical environment largely through sonic maps. Exploring further I learnt how to navigate by sextant, and compared this to the recent development of satellite navigation technologies. Most interesting to me was how the common availability of GPS was transforming people's understanding of place and location, often with the inverse effect of removing the basic orientational and navigational skills used to move through space (Harris and Dekker, 2009).

As part of *Sun Run Sun*, the Satellite Sounders were instruments I designed and built to transform location data from orbiting GPS satellites into electronic sound as one walks through an environment. By presenting this data live as sound, rather than as useful navigation directions, I emphasised the processes of navigation, the satellites coming in and out of focus overhead, and the importance of sound and listening to move through ones direct environment. When there is no change in data, 'silent spots' emerge, and this draws ones attention back to the immediate environment through a sonic awareness. As already mentioned in the Scape chapter, the sonification in *Sun Run Sun* provokes an aesthetic rather than practical response.

GPS data is not as dense as much environmental scientific data, such as the weather data that Polli is working with. However, as she rightly points out, not all parts of the data need to be sonified, in fact this is limited by the amount of sound we can perceive and constructively distinguish between. When choosing the actual sounds, one has to assess the kind of parameters that characterise the data, and make decisions as to how best represent these parameters so that they both combine as a whole in the sonic field, and can be individually identified. These are familiar questions of musical composition, which can be illustrated by describing in more detail the process of sonifcation I experienced in creating *Sun Run Sun*.

The raw GPS data is based on the NMEA protocol for electronic and data communication between marine devices. It is established by the National Marine Electronics Association and is characterised by threads of numbers, letters and symbols separated by punctuation and divided into separate 'sentences' or lines. These update at a rate of once per second and are based on the 32 satellites in the Global Positioning System. I chose the parameters that would be most important for what I wanted to achieve, summarising the data into two parts, firstly the position of satellites in orbit, and secondly the position of the receiver on earth. This technically involved writing software to 'parse' the data into useful chunks and select specifically those parameters. Given that the longitude and latitude coordinates of position are calculated by triangulating the changing positions of at least 3 orbiting satellites, I chose to sonify the 6 strongest satellites at any one time, as they move in and out of focus.

Each satellite has 4 parameters: indentification number (PRN between 1 and 32), elevation (up to 90 degrees), azimuth (up to 360 degrees) and signal strength (or signal to noise ratio). Wanting to keep the sounds as simple as possible in line with the conceptual aim of *Sun Run Sun*, I chose to emphasise as direct a relationship to the source of the data characteristics as I could, given that it is a sonified translation. After several attempts and tests walking through the city, I resolved that these four parameters should map directly as follows: PRN to frequency (oscillator); elevation and azimuth to timbre (phasor) and spatial position in the stereo or multiple speaker sound field; and signal strength to amplitude (volume). The longitude and latitude parameters, which we most closely and usefully associate with navigation, calculated from the raw data, determined the frequency and volume of two simultaneous oscillators that combined into a ring-modulation. This is significantly different in different locations in the world, and the fine tuning of this data (how far you walk or drive) described the envelope making a subtly changing frog-like sound. The majority of sound one hears comes from the satellite positions in the sky rather than the longitude / latitude

position on the earth. Throughout the tests I realised that continuous sound is tiring to pay attention to and distracting from the surroundings, and so I used the 3 changing values elevation, azimuth and signal strength to determine the envelope of the sound (attack – body – decay). With this changing envelope silent spots emerge where there is no change in data. These few seconds of quietness put ones attention back on the immediate environment with the effect that people experienced the back and forth between ones body in space, and the distant satellites.

I learnt from this that the specific choices of mapping data to sound in sonification directly effect the success of the desired outcome. I composed, and recomposed the mapping until satisfied with the physical, psychological and aesthetic effect that I was trying to design. No change or conscious misrepresentation of the data was involved nor the use of external input to influence it. Yet even so, my compositional choices effect the experience of the people using it. These experiences are clear from this image of the navigation data, placed next to the responses from participants immediately after experiencing the *Satellite Sounders* (see discussion in Harris and Dekker 2009). To make a composition independent of the instruments and installation versions of *Sun Run Sun*, I documented these responses and combined the recordings with the Satellite Sounder recordings from four places in the world. This forms a stand-alone sound composition entitled *Satellite Sounding*. The audience responses included in the piece are as follows:

> You're very very self-aware, I would walk around, uh, you know, in the middle of nowhere, uh ok, what do I have to do?
> I just have to walk there?
> hehehehehe,
> a religious experience, disconnected from the world, there are these voices that obviously kind of come from above,
> very funny,
> you are being controlled and watched by some outside alien,
> that's what you feel, being followed,
> sending up a signal, here I am, here I am, here I am,
> when did you think of getting in contact with satellites?
> ddzzzzztschdzzzzzzzz dzzzzzztschhhdzzzzzzzzz
> and what's the point of all this?
> you don't send a signal to the satellite?
> no, no, uh, so how does the satellite find you?

As is evidenced by these recordings, people experiencing sonifications often confuse the source of the sound, and ask where do the sounds come from? Why did you choose these sounds and not others? This is a very valid fear of mis-representation of the data through the sonification process. As it is an interpretation by composer and by listener, this raises questions as to the validity and neutrality of sonification for scientific purposes. Polli cautions that "it is important to always remember that it is an interpretation and also a simplification of the data ... [and] that the numerical data itself is also a simplification" (Polli, 2010). After my experience of this sonification practice, and research into others, I have come up with the following two observations: firstly, when choosing sounds, avoid obvious metaphors (wind sounds to present solar wind); secondly, avoid adding parameters that are outside the data, such as a drone to make the sound more 'accessible'. This correlates with the ICAD report:

> it may be desirable to create mappings between data and sound features that are realistic or "natural," in the hopes that they will be immediately compelling and comprehensible (e.g., a synthesized engine sound for an aircraft display). However, "natural" sounds may, in some cases, lack the number of discernible parameters necessary to represent a data set with many variables (ICAD, 1997: 3.1.2).

In choosing sounds it is important to emphasise changes in the sound patterns and allow space and silent spots without making the sound field too dense to listen to.

4.6 Listening

A very interesting aspect of sonification that is mentioned in the ICAD report is the necessity of training and practice of skilled listeners, citing for example sonar operators, and assistive technologies for the blind. Yet "further research is needed into how performance with auditory displays changes with practice" (ICAD, 1997: 3.1.2). I note that this expert level of skill and the role of practice is reminiscent of a musician to their instrument or ensemble, and is a rare example of tuning into the sense of sound where it becomes intuitive and absorbed into ones reactions (I will expand on this idea in chapter seven on techno-intuition).

The emphasis on the perceptual studies of acoustics as one of the key areas laid out in the sonification research report leads back to my initial comment that things can be inaudible to

us because of a lack of attention to them. Even when we can hear sound, it does not mean that we can understand it. Music offers profound insights into listening and making sense of previously inaudible sound, and often relies on trained and expert listening as will be apparent in the following chapter on underwater sound.

It is hard to over-emphasise the importance of listening as a practice. Ironically, much of what seems inaudible to us is actually audible with the naked ear if we give due attention and learn how to listen. Schafer presents his 'Ear Cleaning' exercises as a starting point, which he defines as, "A systemic program for training the ears to listen more discriminately to sounds, particularly those of the environment" (Schafer, 1977: 272). Pauline Oliveros has refined her educational and personal practice of Deep Listening (Oliveros, 2005). Learning to listen more clearly and understand how other animals and life forms hear and use sound will help us to make the choices and interpretations necessary for successful audification and sonification that are beyond our perceptual range.

5. Whale: An Investigation of Underwater Sound

5.1 Fishing for Sound

Submerging into a sea of sound, it surrounds, immerses my hearing and my being. Underwater I am out of my element, in a medium in which I cannot survive without technical aids and only for limited periods of time. What does it mean to relate to such an environment through sound?

If I dream about underwater sound, and what it means to me, I have an atmosphere of density yet floating, blue light yet darkness, great distance and reverberation yet closeness. I am fluctuating in a sea of sound, full of background noise. I try to identify by listening, I listen to myself suspended, floating in liquid. The sound is like the liquid. And I can pull sounds out, fish for them.

Santiago, the Cuban fisherman in Hemingway's *The Old Man and the Sea* (1952), knows his surface environment, the boat and weather. He knows the underwater environment beneath his boat by the signs he reads from the surface - birds, currents, weed, shoals of fish, the other fishing boats. As the story develops he extends his senses underwater by literally feeling the behaviour of the giant marlin, through the touch of his fishing lines on his hands, his fingertips, and later, his back as it tows him through the sea for three days and nights.

I can catch my sounds from the surface, I can know something of what is down there, through my technology I can listen and by learning sounds and signs from the surface I can understand another medium. I breathe air, I can only visit underwater, I cannot inhabit it. Or can I? How can I begin to understand what it is like, its complexity, and how my activity effects it, if I cannot spend time there? The first time I lower a hydrophone beneath the surface, a probe into water, what do I hear? What other information do I need to collect to understand the underwater environment? I have to listen, and use sound to understand.

5.2 Underwater Sound

Underwater sound intensifies the relationship between human dependency on technological mediation and biological life. Our relationship with the underwater environment is fundamentally defined by how alien it is, an uninhabitable medium, which we can access

through active imagination and immersion. In the underwater environment our physiological human limitations are challenged and our only knowledge of these environments and their sounds must be mediated by technological extensions. The implications for sound research and roles of the composer are considerably more radical and expansive than those of land-based soundscapes where we can have direct access and experience. Exploring this area requires investigating the history, science, technologies and myths of underwater sound.

Except for sailor's tales of sounding deep-sea monsters, the underwater environment generally has been considered a silent place. Our notion of sound and the sea is always related to our technological means to hear it, initially through the slight amplifying qualities of the submerged part of the hull of a boat, more recently through hydrophones. The strange assumption that the sea is silent comes from the limitations of human hearing, combined with an anthropocentric attitude, exacerbated by the alien nature of the underwater medium. The vastness, complexity and fractional knowledge we have of ocean ecologies suggests that we need to change this attitude to find sustainable solutions. The relationship between biological sound and anthropogenic technological sound is not just a theoretical distinction. It is central to our understanding and hearing underwater, and so is built into the history of human relationships with underwater environments.

In the years following World War II, developments in sonar and submarine warfare catalyzed research into underwater sound and a highly specialized form of listening, an enormously expensive and technologically challenging area of development (Payne and McVay, 1971; Stocker, 2002; Helmreich, 2007). During the Cold War human listeners were stationed to monitor the potential sounds of enemy submarines and human activity, trained to effectively shut their ears to other sounds. Reports of strange sounds possibly linked to passing whales and dolphins were reported as they were hard to ignore. Frank Watlington, who worked for the US government listening for Russian submarines, collected recordings of what he believed were humpback whales, from hydrophones deep in the North Atlantic off the coast of Bermuda between 1953 and 1964. These recordings were most probably used by one of the first whale sound researchers, William Schevill, in the 1960s. But it was not until the structure of Watlington's recordings were analysed and interpreted as 'songs' in the seminal paper (Payne and McVay, 1971) and recordings (1970) by Payne and McVay, entitled "Songs of Humpback Whales", that underwater soundworlds entered the public consciousness. The public release of these humpback whale 'songs' almost immediately influenced both mainstream popular music and experimental music, and helped fuel the 1970s and 80s environmental movement (Rothenberg, 2008; 15).

Discourses pertaining to underwater sound have emerged at a complex intersection of scientific research, art and music, military and industrial development, and environmental activism. These discourses are a surprisingly recent phenomenon. In the scientific research and international policy fields, the First International Conference on the Effects of Noise on Aquatic Life, took place in 2007 hosting 250 scientists, regulators and industry representatives to discuss and mitigate the problems generated by the increasing sound levels in the oceans. The second conference has only just taken place in August 2010 after a century of dramatic increase in anthropogenic sound in underwater environments (Aquatic Noise 2010). In June 2010, a scientific article by Dutch scientist Hans Slabbekoorn from Leiden University made international headlines because it drew connections between rising underwater sound levels and declining fish-stocks, with the implication of continuing financial losses for industrial fishing (Slabbekoorn, 2010). Supported by International Marine Mammal Project of the Earth Island Institute, the recent award winning documentary film *The Cove* by Ric O'Barry (Oceanic Preservation Society, 2010) shows current attempts by activists to stop dolphin slaughter by Japanese fishermen and reveals how these fishermen use sound to drive the dolphins to the shore. These examples demonstrate both how new and how urgent this area of research is, and the overwhelming necessity for sustainable approaches to human impact on underwater ecologies. It appears that sound has never been so crucial and played such a dominant role in environmental issues as in underwater environments.

Further research into underwater sound continues to develop in tandem with the technological means to collect, listen and analyze complex and previously unheard sound. Ironically, the rise in anthropogenic noise in the oceans - from shipping, naval experiments and industrial oil and mining projects - has developed hand-in-hand with the ability to listen for and monitor the biological sounds of the sea. However, financial, political and industrial interests in keeping these technological developments secret, hindered civilian knowledge about this enormously complex world of sound. For example, the U.S. Navy SOSUS (Sound Surveillance System), which was the first underwater listening array of hydrophones initially deployed in 1954-5, was only made publicly available after 1992.

> In addition to being able to hear, locate and track individual whales by way of their vocalizations, for the first time scientists also heard the density of anthropogenic sounds that cluttered the marine soundscape (Stocker, 2002: 24).

This unbalanced relationship between the access to high-end technological development and the ability to listen and learn about underwater sound has been sustained by the incompatible agendas of industry, science and environmentalists. The necessity of a more

cohesive, open and collaborative approach is beginning to be addressed by groups such as ESONET (European Seas Observatory Network) which "aims to promote the implementation and the management of a network of long-term multidisciplinary ocean observatories in deep waters around Europe"(ESONET, 2010). The data from these deep ocean observatories is being made available to bio-acoustic scientists and other interested groups. The project LIDO (Listening to the Deep Ocean Environment), uses the ESONET network for live internet streaming of underwater sound and data from these ocean stations in the Mediterranean and North Atlantic. The aim is to give the wider scientific community live access to sound sources and analytical tools to assess levels of anthropogenic and biological sound over long-term periods (LIDO, 2010).

These projects recognise the expansiveness and multidisciplinary nature of ideas provoked by the contemplation and study of underwater sound. Likewise, in his paper 'An Anthropologist Underwater: Immersive Soundscapes, Submarine Cyborgs, and Transductive Ethnography', anthropologist Stefan Helmreich draws on a wide range of trans-disciplinary notions discussed in new media theory, sound theory, anthropology, systems theory and cybernetics, and the history of technology (Helmreich, 2007). In studying the scientists use of sound in a specialized three-person submarine named Alvin, used for mapping deep sea-floor surfaces, he questions the relationship of immersion to the sonorous qualities of underwater life, and the possibilities of human inhabitation of and interaction with aqueous environments through technological and sonic aids. The implications of the study and experience of underwater sound are raised by Helmreich's questions:

> As we drop down to the ocean floor, amidst a wash of submarine sounds, some questions surface: How did the domain that Jacques Cousteau (with Dumas, 1953) once named "the silent world" become so sonorous? How did the underwater realm, this zone to which humans cannot have extended, unmediated access (without drowning, that is), become imaginable and accessible as a space of sound? What kinds of technical work have been necessary to bring this field into audibility for human ears? And what have been the cultural effects – for people in submarines, for example – of such work? Learning the answers requires dipping into some submarine history, tuning into the technical specifics of underwater listening, considering cybernetic networks of communication and control, and querying the multiple modes through which people imagine immersion: as a descent into liquid, as an absorption of mind and body in some activity or interest (such as music), and – in a meaning of relevance

> for anthropologists – as the all-encompassing entry of a person into an unfamiliar cultural milieu. (Helmreich, 2007: 623)

The study of underwater sound demands such a trans-disciplinary research approach where scientists, artists and environmentalists work across their disciplinary boundaries. This may indeed mean facing up to the uncomfortable and challenging difficulties of entering into "an unfamiliar cultural milieu". This Scorescapes research project is an attempt to gather together some of the most significant contributions to underwater sound research across different disciplines from science to musical composition, with the aim of finding new approaches to contribute to a more sustainable relationship to the environment through sound.

5.3 Understanding Biological Ecosystems Through Underwater Sound

The assumption that underwater is silent has been turned on its head in the last decades as scientists begin to understand just how crucial sound is to aquatic life, in a largely dark environment where it is used to detect motion, currents and prey, and to communicate. It continues to be an extremely difficult area to study, as the sound source can often be undetectable. Moreover, little is known about how sounds are produced or used and what they might mean. In *The Soundscape* Schafer devotes only two pages to "the sounds of water creatures". He writes, "many fish have no sound producing mechanisms and no developed organs to hear sounds" citing the few exceptions to this as if characters from an alien world, making sounds by "grinding or snapping their teeth ... expelling gas or by vibrating the gas bladder ... gulping air bubbles and expelling them forcibly through their anus." (Schafer, 1977: 37). It is striking how limited knowledge on underwater sound was at that time, even by specialists in environmental sound like Schafer. Interestingly, Schafer mentions the humpback whale song, although he does not include a specific reference to the scientific source despite reproducing the recognisable analysis and visualisation by Payne and McVay (Schafer, 1977: 38). The lack of reference to scientific journal publications in Schafer's writing suggests a different relationship between the arts, sciences and music research in the 1970s than in 2010, where scientific research was not as easily accessible to non-specialists.

Although research has developed dramatically since Schafer was writing, underwater sound is an endlessly extensive area about which we still know relatively little. In 2002, the International Marine Mammal Project of the Earth Island Institute commissioned a comprehensive report on the state of known knowledge of biological underwater sound by

bio-acoustician Michael Stocker. This was republished by *The Soundscape Journal of Acoustic Ecology* with the full title "Ocean Bio-Acoustics and Noise Pollution: Fish, Mollusks and other Sea Animals' Use of Sound, and the Impact of Anthropogenic Noise in the Marine Acoustic Environment" (Stocker, 2002). The report examines research since 1950, giving an extremely informative overview of the issues of underwater sound, including the characteristics of sound propagation in water, different species' use, production and sensing capabilities of sound, and the quality and effect of human made sounds in the ocean. However, even with this knowledge Stocker states, "while considerable efforts are being made to understand the auditory perception of sea animals, our understanding is miniscule compared to the vast diversity of sea animals and their adaptations to sound" (Stocker, 2002: 18).

Following are some of the key points raised by Stocker that demonstrate the breadth of the topic and the alien nature of the environment to humans. Because of the density of water, sound travels five times faster in water than in air. Because light levels are very low, sound is the primary sensory faculty for biological life. Many species of fish, crustaceans and mollusks can sense both wave motion and particle motion at such sensitive levels as to detect currents, tides and approaching prey. Sound can travel vast distances underwater, reflected through layers of the ocean, a feature used by whales for communication and perhaps by other species for navigation. Cetaceans and other marine mammals use highly developed echolocation to navigate and hunt, and some species like the snapping shrimp stun their prey by sound. Abiotic sounds (natural – sea, storm), biotic sounds (animal), and anthropogenic sounds (motors, seismic explosions, sonar testing) form the three most basic categories of bioacoustics. Underwater sound is in no way bound by human sense perception, extending well into larger and smaller scales, frequencies, time-frames, spatial dispersion and volumes.

Given the field's infancy, it is not yet known how the proliferation of anthropogenic sound may affect long term development of marine organisms and the larger ecology. Underwater bio-acoustic scientist Michel André clearly identifies the problem and suggests that research on cetaceans offers a particularly fruitful line of inquiry into the sustainability of marine ecosystems.

> Ocean noise has always existed, both in natural and biological forms. Without any doubt, due to its recent and uncontrolled character, the massive introduction of artificial sound sources at a large scale has become a threat to it's balance, *more importantly than any other pollution found in the marine environment.* Cetaceans, as top predators of the food chain, have evolved for millions of years on their acoustic

> perception of the environment and can be considered as bio-indicators of the acoustic balance in the oceans. Understanding how marine mammals perceive their environment and unraveling their communication methods means investigating for the conservation of the marine ecosystems and the development of sustainable human activities in the sea (André, 2010, my italics).

These ideas on sound in the ocean suggest that its impact is potentially of greater threat to marine ecologies than toxic waste, oil spills and other forms of pollution.

5.4 Sonic Evidence and the Composer

Every underwater sound raises questions. Sound is, in turn, listened to in order to find answers. In the case of the whale and other cetaceans, sound is the primary way into researching the animals' lives, behaviours, communications, intelligence and interactions within ocean ecologies. The sound contains clues and can be used to prove or disprove hypotheses. In this sense sound is a witness, or 'evidence' to be unravelled within its larger context of underwater environments and ecologies. These are sounds that are entirely embedded in their context, a context in which humans are alien and have difficulty accessing and assessing. In order to make sense of sound in this environment researchers must piece together its function from highly mediated sonic evidence, by correlating the qualities of the sounds themselves with behavioural patterns and contextual knowledge of their environment.

The role of sound within this context is far from what is generally considered as the role of sound within musical practice. However, to incorporate such ideas into one's musical practice may lead to fruitful lines of inquiry. Understanding scientific approaches to underwater sound can offer composers alternative perspectives on the role of music in human terms. It may be possible to go beyond the techniques and common presentation strategies of artistic field recording to include and further develop concepts and techniques specific to underwater sound. And by developing a deeper understanding of scientific techniques, composers will be able to contribute more effectively to research into underwater sound.

5.5 The Whale as a Stage

Research on underwater sound is intimately bound up with the story of the whale. These underwater mammals are known to use sound in a very sophisticated manner. Humans have only recently been able to hear whale sounds and still have very limited understanding of them. The whale's popular appeal, our "natural human empathy for these intelligent, air-breathing creatures", contributes to increased financial support for research, often to the detriment of urgent research into other species (Stocker, 2002:16). Nonetheless the power of this animal in human imagination, the whale's function as "a touchstone for our common knowledge" (Stocker, 2002:18), leads us to further understanding of underwater environments and underwater sound. Interest in the whale goes far further than scientific research endeavours to find out about the specifics of the animal, its sounds, its context and social behaviours. The mythic resonance of the whale often overshadows its qualities as an animal species in its own right.

The whale is an imaginative springboard, a stage on which myths of environmental destruction have been played out. It has catalysed environmental movements and even suggested possibilities of interspecies communication (Lilly, 1962; Bateson, 1972). The whale seems to re-emerge at moments of intense environmental awareness, for example Herman Melville's *Moby Dick* (1851) coincides with Thoreau's *Walden* (1854). The release of *Songs of the Humpback Whale,* the first publicly available recordings of 'whale songs' in 1970, coincides with the founding of Greenpeace in 1971, the growing environmental movement of that era, as well as with the concurrent development of the soundscape studies by the Acoustic Ecology movement. Similarly, a number of recently published books on the whale, including David Rothenberg's *Thousand Mile Song* (2008) and Philip Hoare's *Leviathan, or The Whale* (2008), coincide with current debates about climate change, sustainability and the environment. The figure of the whale again provides a stage on which these debates and questions can be dramatised.

Cetaceans are underwater mammals that breath air. This connection between air and water, between whales and humans, is part of our imaginative fascination with cetaceans, almost like a mirror of ourselves, acting as a bridge between these media. The difficulty of studying these sea animals, as emphasised by Melville in *Moby Dick*, is that we can only have such limited contact with them. It is still barely understood not only why the whales make the variety of sounds that they do, but in many cases how they make them. One of the many extraordinary questions is that some whales make sounds of such intensity that it should theoretically deafen them. Cephalopods - octopus, squid, cuttle-fish, the Kraken or Giant

Squid (the 'Bloop'?) - are even more obscure to humans and yet equally mythical. However, largely due to the bias towards investigations on cetaceans, most scientific research on these animals has focused on their function as food for whales. Recent research however suggests that the cephalopods are enormously sensitive to sound and experience what is scientifically termed 'acoustic trauma' - permanent physical damage to the hearing organ - at very low decibel levels (André, 2011). This would suggest that exposure to repetitive, loud anthropogenic sound is, or will, have drastic consequences for populations of cephalopods that cannot move away from the sound source as cetaceans can. The impact of such an imbalance on the underwater ecology is potentially catastrophic.

Human interaction with the whale crosses art, science and activism. The status of whales as pop icons ironically makes cetaceans a difficult topic to research, largely because of dismissive preconceptions that associate them with a redundant romantic notion of environment, one that favours the 'charismatic' animals, or the star of the film *Flipper* (1963). A plethora of whale projects founded this on romanticism and often incorrect scientific information do a disservice to this important area of study. Alongside artistic approaches, run scientific research endeavours into communication through sound in underwater environments. But even these researches seem to generate myths of their own, for example the films made around the character of dolphin researcher John Lilly and his scientific experiments in interspecies communication (Lilly, 1962). Calling on Bateson's notion of double description, he added, "The richest knowledge of the tree includes both myth and botany" (Mary Catherine Bateson on her father Gregory Bateson) (Bateson and Bateson,1987). The various interpretations of the figure of the whale - in science, as song and music, as spatial composition, and as encompassing long distance and interspecies communication - gain richness by the interaction between the whale as a stage for myth and as a subject of scientific research.

Scientists calling on the help of music to analyse whale sounds is rare and controversial but also illuminating. They raise critical questions about 'music in nature', 'beauty', and the function of music as a communicative or even evolutionary force. Dunn's opinion that, "Music is one of the most profound means we have for growing the capacity to perceive the world through sound" (Miller, 2007: 14) highlights the tensions between our definitions and understandings of the role of music and its relationship to sound in the environment.

The following discussion addresses three seminal works on whale sounds - two by scientific teams and one by a composer - that have not previously been considered in relation to each other. Particular attention is paid to their different approaches to sonic context. I compare

Payne and McVay's analysis of humpback whale sounds as 'songs', with marine scientists André and Kamminga's work on decoding the click trains of a sperm whale pod using rhythmic analysis, and composer Alvin Lucier's interpretation of sending sounds over extremely long distances in *Quasimodo the Great Lover*. The first deals with notions of song and melodic pattern structure revealed through visualisation techniques, the second about rhythmic ideas of spaces between clicks as percussive sound in environment, and the third about processes of transmission through sonic environments emphasizing context.

5.6 Humpback Whale Songs

The seminal paper 'Songs of Humpback Whales' with accompanying recordings by Payne and McVay, remains one of the most clear and accessible reports on whale sound and is worth examining in more detail. The research is significant for a number of reasons: firstly, they were the first publicly available recordings of whale sound; secondly, they use a primitive visualisation technique to discover and analyse the sound patterns; and thirdly, the authors use simple musical analysis to describe these sounds in terms of songs, themes, phrases and units. As previously mentioned, they describe a series of recordings of humpback whales over a number of years from the coast of Bermuda. They report "It is from these studies of the herd sojourning these waters that we have become aware of the humpbacks' most extraordinary feature – they emit a series of surprisingly beautiful sounds, a phenomenon that has not been reported previously in more than a passing way." (Payne and McVay, 1971: 585).

Drawing on aesthetic musical notions, these "surprisingly beautiful sounds" are described as "the humpbacks' sonic repertoire". Payne and McVay justify their use of the term 'song' by referring to a report by Broughton (1963) on classification of animal sounds where he defines song as "a series of notes, generally of more than one type, uttered in succession and so related as to form a recognisable sequence or pattern in time." (Payne and McVay, 1971: 590). Rothenberg in *Thousand Mile Song* opines "too many whale scientists consider beauty to be too subjective to trust that term to describe the sounds they spend years studying ... it's a shame they forget that nature offers up beautiful music as well" (Rothenberg, 2008: 133-5). But how helpful or misleading is this discussion of whale sound in relation to human music? To judge an idea of musical beauty in natural sounds, when ideas of beauty are contentious even in human music encourages an interpretation of whale song as some kind of animal form of music making, overruling important questions about communication. Such

an attitude suggests a largely anthropogenic approach towards the topic, a circular logic that reflects back on our own notion of what music is.

Extraordinary differences in the relative hearing capabilities between whale and human result in an inevitable compromise in the analysis of these sounds, as with most animal sounds, a fact that emphasizes the importance of making the inaudible audible or visual (Harris, 2010). The association of whale sound with human music forms the basis of Payne and McVay's analysis, even though the whales emit frequencies beyond our hearing range and outside of our temporal perceptions with durations either too long or too short. Recognition of this fact is noted in the paper's subtitle "Humpbacks emit sound in long, predictable patterns ranging over frequencies audible to humans", and later reference to analysis of the 'unit' as "the shortest sound that is continuous to our ears when heard in 'real time'", as different from the 'subunit' that must be "listened to at slower speeds, or analyzed by machine". Further, "An interesting sound that is sometimes superimposed on the grunts may represent the audible component of a train of ultrasonic pulses, but this possibility must await recordings on equipment sensitive to ultrasound" (Payne and McVay, 1971: 594). On first listening to these humpback whale sounds one has "the impression of an almost endless variety of sounds" because the temporal length is beyond what we can easily hold in our minds (Payne and McVay, 1971: 594).

As a result of this limit to human sonic abilities, another approach had to be taken. It is significant that Payne and McVay's discovery of song structure came from the visualisation by the spectrographic analysis of the recordings. The "exceedingly tedious process" involved extracting 9.6-second segments of tape-recorded sound and analyzing them on a spectrograph, to graphically represent the frequency, amplitude and time in a visual image. These printed segments were carefully matched, glued together and reduced in size to make them manageable to see altogether as an overview. These spectrograms were then traced onto new sheets of paper by hand, to clarify the whale sounds from the background ocean noise and echoes. This level of interpretation of the images of the sounds removed the parameter of amplitude, leaving diagrams representing frequency (pitch) over time (Payne and McVay, 1971: 592). This choice of what information to remove from the spectrograms resulted in an interpretation of the whale song that conforms to the basic parameters of Western musical notation. To depict something sonic in a visual form that is conventional for music, and then "discover" music in it, appears to be a tautology.

Payne and McVay's spectrogram notations of whale recordings seem to implicitly suggest a reading mode like a graphic musical score, where the repeating patterns become visible,

analysable and comparable to other notations. The first form of graphic analysis presented is the entire song in both spectrogram and graphic tracing. From this they deduced a hierarchical scheme of temporal structure summarised as follows: "subunit < unit < phrase < theme < song < song session", the first of which is too small to be detectable by the naked ear, the last of which can continue for hours (Payne and McVay, 1971: 591). The structure is clear, recognisable and repeatable, but there is distinct variation in the detail rather than the overall. They discovered that the sequence of themes stays consistently in the same irreversible order. The place of most variation occurs in the phrases that make up the distinct themes.

The second form of graphic analysis examines these slight variations in phrases. By layering phrases vertically above one another as they appear in temporal sequence, we see how these phrases "systematically change, or 'evolve', with each successive repetition during the theme" (Payne and McVay, 1971: 593). Subsequent research has shown how humpbacks evolve new songs over seasons, years and large distances, although it is not known why these transformations happen. The visual presentation is suited to reveal the qualities of the phrase evolution, which in one theme is almost like stretching; in another, more like addition. It not only shows the sounds made, but also the variations in the spaces between sounds. In one of their example themes the phrases seem to repeat with great regularity, suggesting what composers would term a recognisable rhythm. However, 'Theme 2' does not ideally fit into this analysis as it consists of one long phrase. "It may consist of a great variety of sounds, but all, or most, of them are ascending frequency sweeps or brief (less than one second) high-frequency squeaks or chirps" (Payne and McVay, 1971: 593). This is a strange phrase/theme because there can be so much variation in the detail of spacings between sounds or units. The "interunit spacing" is only mentioned in passing and is not given consideration as a potentially important aspect of the sounds, the assumption being that the sound alone contains the information, the 'on' rather than the 'off'.

The inclusion in the paper of both the spectrograms and the graphical tracing side-by-side enables the reader to compare the two levels of visual interpretation. Moreover, by noting what is excluded in this process of translation from one graphic form to another, reveals that the environmental contextual information within the sound recordings is diminished. Of the elements visible in the spectrograms but excluded in the tracings, the most prominent are the contextual and spatial characteristics of the underwater sound environment that are clearly audible when listening to the recordings. In the recording *Songs of the Humpback Whale* (1970) which includes a voice-over describing the chief characteristics of their

discoveries, the echoes in particular are mentioned, "the water is very deep and the sounds are echoing off the under-surfaces of waves and from the submarine canyons and ridges on the island's slope" (Payne and McVay, 1970). These echoes are visible in the spectrograms, as shapes with a shadow that repeats three times in very close succession, but are excluded in the tracings as they are distracting to the visual clarity required to recognise the patterns in structure. Another example of excluding the environmental context in which the whale sounds are made, includes dynamite blasts occurring in pairs every ten minutes. The authors conclusion from extended listening is that "the blasts do not have any detectable effect on the whale's rendition of its song" (Payne and McVay, 1971: 586). The sounds emitted by the whale are prioritised over what is actually recorded and how the sound behaves and transforms in interaction with the space and other sonic events in it. This approach applies an idea of communication that requires removing noise – unwanted interference - from information. The more we accept the relativity of sound and theorise the relation between sender and receiver in terms of spatial context rather than direct communication, as will be seen in both André and Kamminga's work on sperm whales and Alvin Lucier's *Quasimodo*, the less we can afford to continue to exclude the role of the underwater sound context within these recordings.

I discussed this notion of the spacing between sounds as carrying information with André in relation to his research into the possible communicative function of sperm whale clicks. Substantiating my above critique of Payne and McVay's important work from the 1970s, André's hunch of the relative importance of non-sounding to sounding in sperm whales became the basis for his RIME hypothesis described below.

5.7 Sperm Whale RIMEs

In their paper on echolocation in sperm whales, André and Cees Kamminga report research into the rhythmic function of clicks used for echolocation, and suggest their simultaneous potential for communication and identification (André and Kamminga, 2000). This research is significant in its implications for whale communication, as well as for methodology. The authors combine scientific techniques of analysing the time intervals between clicks to reveal dominant rhythmic patterns, with the listening observations of a Senegalese drum master, expert in identifying dense polyrhythmic patterns. By conducting these rhythmical analyses on the apparent cacophony of sperm whale clicks, they drew on musical concepts of rhythm,

which became what they call RIME (Rhythmic Identity MEasurement), to unearth potential uses of these sounds for communication.

Payne and McVay distinguish different kinds of sounds produced by the Mysticete or baleen whales such as the humpback or fin whale, and those made by the Odontocetes or toothed whales which includes the sperm whale, killer whale, dolphins and porpoises. Unlike the varied 'song' of humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*) emit 'trains' of clicks. Regularly spaced click trains were thought to be used for echolocation, and the observation of moments of irregularly spaced clicks, named 'codas' (note another musical term), were considered for communication. In contrast, André and Kamminga argue that "the exclusive function of echolocation attributed to the series of usual clicks might be too restrictive" (André and Kamminga, 2000: 164).

They suggest that the clicks may play an important role in helping large groups of sperm whales communicate over distances of several kilometres. "The social character and the cohesive behaviour of the sperm whale suggests a continuous exchange of information which cannot be based on visual cues, given the great distances over which the whales are separated while looking for food and the virtual absence of light at foraging depths." (André and Kamminga, 2000: 164) The scientists noticed that during foraging they emit these click trains (not the 'codas') and that the whales never parted further than six miles, perhaps to stay within acoustic range of their pod. Is it possible to deduct from their sounds if and how they communicate through them? Much like the first listening of the humpback songs, the clicks from a pod of sperm whales appear to be a cacophony with no discernible order. If they contain some communicative information (more than echolocation functions), how could we recognise this? André and Kamminga hypothesise that "the temporal aspects of these signals are crucial to information transfer, since pulse timing is less subject to environmental distortion than wave form" (André and Kamminga, 2000; 164). By considering the contextual aspects of group behaviour in relation to the clicks and the way sound travels in the underwater environment, they start to investigate possible rhythmic patterns unrecognisable to humans. I note that this stands in contrast to Payne and McVay's exclusion of context in their interpretation of humpback whale sounds.

The most radical and controversial aspect of André and Kamminga's research lies in its hybrid, interdisciplinary methodology that combines both high-end analysis techniques accepted by the scientific community, and direct auditory observations by a human listener expert in polyrhythmic music. André connected the rhythmic expertise and social cohesion of West African drumming with the possible connection to sperm whale clicks. He played a

sample of the whale recordings to the Senegalese drum-master Arona N'Daye Rose, who was "spontaneously able to separate and identify the individual whales in the sample recording through their strong individual rhythmic structure." N'Daye Rose deduced from first listening the number of whales in the group and detected a dominant rhythm around which the others were organised "belonging to what he called the leader of the group, in reference to the organisation of the rhythmic structure of an African tribe" (André and Kamminga, 2000: 164). André remarked "We knew there were four whales because we took notes during the recording, but all we heard was a confusion of clicks. I asked Arona how he could tell there were four different animals. He said, 'I don't know how, but I know.'" (Rothenberg, 2008: 181)

Although the musician could identify these social details communicated through rhythms, the scientists needed to have that observation corroborated by scientific analysis. N'Daye Rose's analysis was "spontaneous" but it took the research team months to prove. André and Kamminga detail these levels of analysis which identify the "pulse repetition frequency (PRF)" and the "inter-click interval (ICI)" as parameters for calculation, from which they pull apart, or parse, the click trains of individual whales revealing their distinct acoustic signature. From this they determine the idea of RIME, which they suggest is a learned behaviour, much like the West-African drumming traditions, shown by each member of the group. Crucially, it "identifies each individual by the rhythm of its acoustic signals – a time parameter – and not through the shape of the signal wave forms" (André and Kamminga, 2000: 166). Again in contrast to Payne and McVay's 1970s 'songs', this RIME project shows how much information can be gleaned from the spaces between the sounds, and the contextual information of behaviour and medium, rather than only considering the content of the emitted sound itself. It also demonstrates the value of music's knowledge to scientific research on sound.

Every new research step seems to reinforce a sense of the previously unimagined complexity of the underwater environment revealed through its sound. Payne and McVay opened up a world of sound and questions of structure, behaviour and meaning in humpback whale songs, creating a basis for future researchers to build upon. André and Kamminga, by suggesting that the sperm whale clicks actually have a double function, that of echolocating and communicating at the same time using the same sound, allowing the whale "to distinguish its own echoes against the background of other whale click trains" (André and Kamminga, 2000: 166). This insight opens up unimagined complexity and sophistication in the whales

connection between sound and its environment, an approach that is applicable to research on other marine species.

5.8 Alvin Lucier's *Quasimodo the Great Lover*

These scientific examples of humpback whale songs and sperm whale RIMEs open up ideas and questions around visualisation techniques and musical scores, long distance sounds, and possible relationships between science and art. Many musicians were inspired by early scientific recordings of humpback whale sounds. Composer Alan Hovhaness' *And God Created Great Whales* (1970), scored for symphony orchestra and tape, juxtaposed recordings of humpback whales with acoustic instruments. Composer George Crumb incorporates whale sound in less direct manner in *Vox Balaenae (Voice of the Whale)* (1971) which explores extended techniques of piano, flute and cello to imitate the kinds of vocalisations produced by the whale. More recently, the work of musicians and composers, including David Rothenberg and Dunn, reference André's scientific research. Alvin Lucier's *Quasimodo the Great Lover* (1970) was inspired by the humpback whale's ability to send sounds over very long distances. Lucier attended a lecture by Payne at the University of California Santa Barbara in 1969, prior to the publication and record release. In an interview with Douglas Simon he describes his impressions, which resonate with the discussion above of Payne and McVay's work, and give an example of the kind of influence these recordings had on composers of the time.

> While I was there, Roger S. Payne came to give a lecture-demonstration and play his recent recordings of whale music. I, like everyone else, found it very beautiful. What struck me more than the sounds, however, was the ability of whales within a species to communicate with one another over tremendously long distances, across ocean basins in some instances. They do this by echoing their sounds within a specific temperature layer in the sea so that the sound doesn't get absorbed into the bottom of the ocean or dissipated out through the surface. I was very impressed by that. So instead of imitating the sounds of the whales, or using Payne's recordings, I imitated the feature that struck me strongest, their amazing long-distance sound-sending ability. (Lucier, 1995: 112)

Lucier transforms this "long-distance sound-sending ability" into a work that can be set up to travel through almost any medium, linking different acoustic spaces by relays of microphone-amplifier-loudspeaker, accumulating the subtle differences of a sound that is passed through

them. *Quasimodo the Great Lover* is the last in a series of works "which explored the acoustic characteristics of natural and architectural spaces" (Lucier, 1995: 428). The other three works included *Chambers* (1968) for resonant objects as portable environments, *Vespers* (1968) exploring spaces using echolocation devices inspired by bats, and *I am Sitting In A Room* (1970) based on a spoken text that is re-recorded and played back within the same space over and over again. *I am Sitting In A Room* and *Quasimodo the Great Lover* are both systems that explore how the accumulation of sound in loops can bring out the inherent sonic qualities of acoustic spaces. In a kind of mirror of each other, the first explores the resonant properties of a single space as activated and transformed by a voice, playback and recording loop, the second by using a repetitive process to string spaces together into an elongated form of transmission. One system is a closed loop feeding back on itself, the other moves in a forward direction.

To send a sound over any distance requires a signal, a medium and a receiver. This system, multiplied over on itself, is a way to send the sound further than the limits of the medium allow, like a chain or relay, but in the process it collects discrepancies. *Quasimodo* was inspired by the ability of the humpback whale to make sound that is heard hundreds of miles away from its source, using the temperature layer in the oceans that allows the least diffraction of the sound wave, and the most suitable frequency and amplitude levels to derive the greatest effect from the medium. Thinking beyond the medium of water, however, Lucier extends the possibilities for using different media dedicating the score of *Quasimodo* "for any person who wishes to send sounds over long distances through air, water, ice, metal, stone, or any other sound-carrying medium, using the sounds to capture and carry to listeners far away the acoustic characteristics of the environments through which they travel" (Lucier, 1995: 318)

Interestingly, and quite typically for Lucier, the text score was written after the first performances, allowing him freedom to suggest possibilities that he would like to try out in the future. What was learnt in his performances concretises into a score that can be practical yet open to variation: "I've often dreamed of doing it in steel, or in rock, or in earth, or underwater … I'm composing it after the fact of those performances we did, but before the fact of many other versions I want to do" (Lucier, 1995: 108). This piece is not initially conceived as a score, but rather it emerges in score form through the practice of making one or more versions of the piece. The score in this case is a part of the larger system of development, performance and transmission of the idea, but does not precede, or command the system in a hierarchical manner. As such it provides a fascinating hint towards

a scorescape that blends environment, sound, and technology in a mutually dependent system.

The system of *Quasimodo* consists of a chain of microphones and loudspeakers that passes from the first space where the sound begins, through adjacent spaces to the final performance space. In each space the loudspeaker and microphone are placed as far as possible from each other to get the maximum distance. Playing the sound activates the acoustics of the particular space, which is re-recorded by the microphone. This accumulated sound is passed to the next space by means of an audio cable where it is reproduced on the next loudspeaker. The adjacent space is likely to have totally different acoustics properties. In this way the sound of one space becomes the input for the following resonating sound space. This relay system can continue over any distance and through any number of spaces, collecting a sound that is transformed by each acoustic space it travels through. The end result, at the final location of the chain, is an accumulative sound based on transfer over distance by means of alternating transduction of sound from electronic signal to sound waves transmitted through a medium such as air.

This "system" (as Lucier calls it) of sound transmission, transduction and acoustics, is dependent on the specific sound input at the beginning of the chain. Lucier builds directly on Payne and McVay's analysis of the humpback whale song, using it not as a sound source in itself, but rather as a model for potential sounds, sound transmission and evolving structures. Sounds are not limited to vocal or instrumental ranges, timbres, envelopes and durations but can be modified by electronic, mechanical or any other means at the input stage only. Beyond the input source and mediating equipment, which could be of a limited variation in quality, only the acoustic qualities of the environments will distinctively change the sound. In doing so Lucier emphasises one 'voice' as the source of the sound, echoing a whale's ability to communicate and send its voice over vast distances.

The text score of *Quasimodo* is described by Lucier as "a guidebook of sounds suitable for acoustic testing, with suggested procedures for putting them together" (Lucier, 1995: 112). The form of the score is in three noticeable sections, first describing all the possibilities for how and where to set-up the piece, then how to consider the kinds of sounds and developments to use as input material at the beginning of the chain, and finally opening up further possibilities for variations and future instantiations. Far beyond the technical specifics, the score lists diverse kinds of spaces, environments and contexts for this to explore, "prairies, glaciers, or ocean basins … rock formations within faults, detached railroad cars

on sidings, the rooms, foyers, and corridors of houses, schools, or municipal buildings … libraries, laboratories, cafeterias, offices …" (Lucier, 1995: 318).

The score outlines the kind of sounds to make and the structural progression of these sounds in the system. Both these elements have direct resonance with the whale sounds. The sound source is described abstractly, "compose a repertory of simple sound events such as … upward and downward sweeps … accelerating or decelerating pulse trains, upward sweeps followed by tones of short duration …" (Lucier, 1995: 320). The score is more specific about the possible structures of these sounds, "Design formal structures with sets of successions of sound events in which each event within a set is subject to gradual, repetitive, and cumulative variation with respect to pitch, timbre, amplitude, envelope, or any other aspect of sound and time in order to amplify in time the relationship between the original sound event, its change, and the environment through which it travels" (Lucier, 1995: 320). Two aspects are prominent. Firstly, the way the sound events in *Quasimodo* evolve through variation is reminiscent of the way in which Payne and McVay described how whale songs "systematically change, or 'evolve' with each successive repetition of the theme" (Payne and McVay, 1971: 593). Secondly, the consistently irreversible order of themes in whale songs, is reflected by "taking care not to reverse the direction of a variation between two adjacent sets" (Lucier, 1995: 320). Perhaps most importantly however, unlike Payne and McVay's analysis of Humpback whale song, but more like André and Kamminga's analysis of Sperm whale click trains, the transformation of the sounds in *Quasimodo* is tied to their presence and transformation in the environments they travel through. This aspect of the sounds interaction within environment makes the piece focused on sonic qualities that move beyond the details of the sounds themselves, making clear that sound is never independent from the environment in which it occurs.

5.9 Physically Experiencing Sonic Processes

Lucier's translation of whale sound into sonic processes occurring in an air environment gives access to understanding underwater sound in an embodied manner. In order to test my ideas through practical experience rather than only theoretical speculations, I initiated a performance of *Quasimodo* at the Atlantic Center for the Arts in Florida (2009) where Lucier was Master Artist, put together by his Associate Artists including myself. We linked the spaces of the Center, through the tropical forest environment. Each interior and exterior space differed in scale and acoustic characteristics, as well as levels of humidity and

temperature. I was impressed by the quality of sound accumulation as one physically experiences it moving from one space into another. It made me conscious of how I sense the changing qualitites of space as I walk across a threshold from one space into another.

My experience of this piece led to the insight that the sound enhances the other senses. I could see, feel and smell the differences between a room, a corridor, and an exterior space. By accentuating the acoustic properties of the spaces my attention to their specific characteristics and their differences was heightened. At the same time the directional long-distance sending of the sound through these proximate spaces enhanced an idea of continuity and forward motion, of passing thresholds, of accumulation, resonance and a relational consideration of the sounds. As I travelled through this long and varied distance, my body and senses activated by the piece, I could sound out the spaces and experience what happens between them.

There is something captivating about this piece that is hard to describe without actually experiencing it – a quality often associated with Lucier's music. The sound seems to be a strange acoustic shadow of travel through these spaces, like an experience of the architecture but absorbed and removed from the spaces into a kind of live memory as one hears these sounds. There is a tension that the person playing, sending the initial signal, is unable to hear the transformations of the final sound being heard by the audience. The performer is physically removed and isolated, and yet still very present.

Although this piece relies on physical spaces, the transduction into electronic media that is required between microphone and subsequent loudspeaker, it could be extended beyond the bounds of a cable. It could, for example, be thought of as being sent over a computer network, connecting a chain of very distant locations. Sound artists Laura Cameron and Matt Rogalsky organised such an Internet version of *Quasimodo* in 2009 (Cameron and Rogalsky, 2009). This version raises the question of how physical one's real experience of space is and how is this changed by wireless or networked transmission. Does *Quasimodo* need to be linked together by chains of cable and acoustic environments? The nature of the piece would seem to change because it is no longer about physically proximate spaces chained together over distance but distributed nodes chained together by a system already in place. Technically, it is now easy to send sound over global distances. But this stands in contrast to the embodied experience of linked accumulations across neighbouring spaces, the directness of experiences of built and environmental spaces through their acoustic properties in situ. Long distance and wireless transmission of the electronic stages require spaces that are physically distant but virtually linked together. This is based on a different understanding of

spaces and their juxtapositions that has been absorbed by long distance proximity over network infrastructure. I argue that the accumulation of the acoustics of distant spaces has a different effect on our bodily experience of space than those linked together in physically adjacent spaces within a locale. In such an interpretation of *Quasimodo* one can only experience *representations* of distant spaces rather than the spaces themselves.

Lucier's work draws the participant into the process of transmission over long distances through environment, as paralleled by the whale underwater but directly experienced in our own environment. This participation demands an imaginative leap away from musical metaphors such as song or rhythm, situating the participant inside a sonic environment that is being activated in a way unusual for us as humans to experience. In this way Lucier requires the listener to participate, to become involved on a conceptual level through listening and experiencing on a physiological level. My own works such as *The Pink Noise of Pleasure Yachts in Turquoise Sea* (2010), *Fishing for Sound* (2010) and *Swim* (2010-11) build on this approach to involvement, not so much by direct physical interaction, as by a level of commitment to listening using a first person perspective and multi-sensory video and sound, to draw one in to sound worlds that are unfamiliar. This kind of approach can, I believe, move us closer to redefining the role of composers and sonic ecologists as activators of a sustainable attitude towards the sonic environment, one that is less passive than the genre of field recording and more immersed and committed to the environment.

5.10 Long Distance Sounds

The question arises as to how does the physicality of experiencing these proximate or virtually connected sound spaces in *Quasimodo* relate to the experience of underwater sound. How does the idea of sending sounds over long distances relate to both the particularity of different media such as air, water, earth or metal, and contemporary experiences of long distance communication over the internet? And how does the figure of the whale, sending these communications across oceans, relate to the human imaginings of long distant communication via telematic networks and other forms of remote transmission and reception? And what implications might this have for musical composition and the sonic ecologist?

Unlike sound conveyed by global electronic networks, the whale actually inhabits and moves through the medium it uses to send the sound, without transduction of any sort. Writer Steven Connor suggests that, "the development of radio… would be identified with the air

through which it was for the most part transmitted, rather than through the sea or earth" (Connor, 2008: 161). But even our use of air to send wireless radio transmissions requires some form of transduction to broadcast and receive the radio signals. In the case of the whale, communication is more direct, "whales actually pass through these extended physical spaces with their own bodies, emitting and receiving sounds that 'echo off the under-surfaces of waves and from … submarine canyons and ridges' to use the words of Payne and McVay from 1970" (Shanken and Harris, 2010). Thoughts about the "presentness" of sound for the whale, the being in the medium, prompt one to dream, "what might it be like to experience a form of direct communication over hundreds if not thousands of miles and/or across time? To intimately know one's position in space on three axes and the relationship of that position to the contours of a vast environment and to the locations of others? Is this perhaps something that humans already do?" (Shanken and Harris, 2010).

This line of thought consciously reflects imaginative ideals of long distance communication and connection. Connor opens his article on atmospherics by saying "wireless signalling unleashed a dream of absolute communication and universal contact. Contemporary communications – or the material imagination which makes sense of them – still have as their ideal horizon a universe of absolute transparency and traversibility" (Connor, 2008: 159). Historical explorations into telepathy, globally distributed consciousness, synchronicity, and their relationship to technological development, particularly electricity are revealed, for example, by media theorist Siegfried Zielinski's media archaeological approach in *Deep Time of the Media* (Zielinski, 2006). Early telematic works include telephone and radio networks such as *Public Supply* (1966) and *Radio Net* (1977) by artist Max Neuhaus, and the use of a satellite telecast in *Hole in Space* (1980) by media artists Kit Galloway and Sherrie Rabinowitz who linked large public screens in New York and Los Angeles to make what they called a public communication sculpture. These ideas continue to develop in the work of media artist Roy Ascott and composer Pauline Oliveros. Attempts to achieve altered, extended states of consciousness, through shamanic practices, sonic meditation and dream practices, are combined with technological developments and tools for communications and improvisations over global distances. The theoretically dense and visionary work of Ascott presents the ideal of distributed consciousness as a "telematic embrace" in his essay of 1990 (Ascott, 2003: 232-46), while Oliveros' "telematic music" which she began in 1991 (Oliveros, 2009) is expanding through her international network of "Deep Listeners" connected via social media sites. Both Oliveros' Deep Listening Institute and Ascott's Planetary Collegium PhD network for media arts researchers show how artistic practice has led to the development of global educational programs that utilise distributed, connected learning by

combining both virtual networks and local nodes to enable hybrid forms of communication and community.

Quasimodo seems to foreshadow these practices of long distance connectivity and communication. But the realities behind the ideals of perfect communication are, as Connor points out, rife with interference, delays and noise (Connor, 2008). Are there similar interferences underwater, where the whale's communication channel is, after all, not exclusive to its signals?

The whale's use of the "specific temperature layer in the sea" that so inspired Lucier, is scientifically described in Stocker's report on underwater sound (reproduce diagram here, Stocker, 2002: 27). Because the speed of sound depends on the density of the medium, sound travels faster in water than in air. The density of water in the ocean depends on temperature, pressure and salinity, which change according to depth. "As the ocean gets deeper, the pressure rises increasing the density, and thus the velocity" of sound. According to these parameters the ocean is generally divided into four distinct layers, each defined by the changing environmental factors of temperature, seasons, weather systems and ocean currents. The surface layer, and the two lower layers referred to as the seasonal and main thermocline, vary according to these environmental factors. Below this, beginning at a depth of anywhere up to 4,000 feet, there is a thermal boundary in the ocean, "this abrupt thermal and density boundary acts as a sound reflective surface underwater" (Stocker, 2002: 27). This lowest, or deep isothermal layer, is the most dense and the least affected by turbulence, with a steady temperature of about 4 degrees C, and so can carry sounds at highest speeds and furthest distances with least interference. It is likely that whales use this channel for their long-distance communication, but also probably for navigation during migration, by listening to distant sound sources made by waves and currents around ocean geographies. "In this 'sound channel', whales have been heard at distances exceeding 1500 miles, and anthropogenic noise has been transmitted over 11,000 miles in the Heard Island Feasibility Test (HIFT)" (Stocker, 2002: 27).

Of course, practical tests to research possible sending and receiving of sounds over long distances using this ocean sound channel have been executed, with varying success and almost always contributing to high levels of anthropogenic sounds in the oceans. The HIFT experiment from 1991 proved the efficiency of sending and receiving sounds across oceans by transmitting extremely loud sounds within this channel. With this knowledge the ATOC (Acoustic Thermography of Ocean Climates) program began in 1996. It hoped to gain reliable confirmation of global warming by monitoring temperature changes in the deep

ocean isotherm based on changes in the speed of sound. Stocker notes that it was "the first pervasive deep-water sound channel transmission, filling an acoustical niche previously only occupied by deep sounding whales and other deep-water creatures" (Stocker, 2002: 25). The tests were scheduled to last ten years with periodic twenty-minute sound transmissions every few hours. Ironically, the concern with pressing environmental issues of global warming ended up causing other serious environmental consequences by contributing to very high levels of anthropogenic sound in the oceans, creating interference in the whales' sound channel!

These issues of very long distant ocean sounds have been placed in a more detailed context by Kahn in his paper entitled 'Long Sounds' (Kahn, 2010).

> The reflex is to imagine a long sound as a held note, a drone, an 'eternal music', or something murmuring away on a geological or cosmological time-scale. Yet there are also long sounds that have travelled a great distance or, more importantly, have acquired their specific character from all that occupies the in-between, the channel, the medium of space. They are sounds that are long on time and long on space. (Kahn, 2010: 52)

Kahn's examples of long sounds include volcanic eruptions, electrical disturbances listened to on telegraph wires, bombs and earthquakes, the ionosphere and ocean. They span the media of air, metal, earth and water, reminiscent of Lucier's wishes for future performances of *Quasimodo* "in steel, or in rock, or in earth, or underwater" (Lucier, 1995: 108). Kahn compares Lucier's piece *Sferics* (1981) which uses antennas to hear sounds of electromagnetic bursts coming from lightning storms in the ionosphere, a technique accessible to both scientists and amateur 'space' listeners. These sounds are generated within a sound channel, the 'earth-ionosphere waveguide', reminiscent of the deep ocean channel. In a recent installation of *Sferics* in Den Haag (Lucier, 2010), one could hear the fragile small sounds of these enormous spatial events in the ionosphere. As Kahn wrote, "It is not merely a remarkable shift in magnitude, from global and larger-than-global expanses to little blips, but more the embodiment and foreshortening of such an expanse in a little blip" (Kahn, 2010: 58). We experience a similar sense of awe at these long distant sounds whether in the ocean or the air, and they feed our parallel fascination with developing long distance communication.

5.11 (Inter-Species) Communication, Evolution, Music

> We must strip ourselves, as far as possible, of our preconceptions about the relative place of *Homo Sapiens* in the scheme of nature. If we are to seek communication with other species we must first grant the possibility that some other species may have a potential (or even realised) intellectual development comparable to our own. We cannot continue to insist that man is at the top of the evolutionary scale and that no further evolution is possible. This vain assumption may be preventing valuable kinds of research. (Lilly, 1962: 21)

While one of the dreams provoked by whales is long-distance communication and connectivity, another lies in possibilities of inter-species communication, of understanding and communicating with an alien other through language, sound or music. Lilly began early work with dolphins in the 1950s. Initial research, which saw a series of dolphin casualties caused by lack of knowledge of their breathing system and intolerance of anaesthetics, included electrical brain stimulation experiments on restrained dolphins kept for long periods of time in a glass tank in a laboratory. These experiments led Lilly to startling discoveries into the potential intelligence of these large-brained mammals, which seemed to corroborate his intuition. In 1958 he began to put forward the idea that "perhaps dolphins are much more intelligent than we give them credit for … we are severely handicapped in our efforts to measure the intelligence of individuals of other species than our own" (Lilly, 1962: 83). In the same year he began the development of his own, independently funded, Communication Research Centre in the Virgin Islands to test the possibilities of communication between different species of similar brain size, specifically between the *Tursiops truncatus* bottle-nosed dolphin and humans. This period of his work is described in his book *Man and Dolphin* published in 1961. Of the fundamental and provocative research questions underlying this study is, he explains:

> One of the last remaining thrones upon which man places himself is being shaken if not toppled by modern scientific research. Man thinks of himself as the most intelligent species on earth and as proof of this points to the accomplishments of his hands, his aspirations, his traditions, and his social organisations. In other words, man is said to be the most intelligent species because of what he does with his huge brain. May there not be other paths for large brains to take, especially if they live immersed in some other element than air? ... In the case of the Cetacea, which are without benefit of hands or outside constructions of any sort, they may have taken the path of

> legends and verbal traditions rather than that of written records. Have they or haven't they? That's the essence of this research (Lilly, 1961: 95).

The success of this inter-species communication research depended on teaching the dolphins human language and understanding their range of sound producing abilities. Lilly noted the dolphins ability to recognise the limited hearing range of humans and restricting their frequency range so as not to produce ultrasonic frequencies humans cannot hear. Although he optimistically says "Luckily for us, a good deal of their natural communication is within our hearing, though in its upper range" (Lilly, 1961: 146), he notes that the meaningful patterns of their speech may be in the ultrasonic range and not overlap ours at all. He describes games of whistling between dolphin and human and use of mimicry, with some examples of specific phrases repeated by the dolphin. Lilly recognised that recordings of the dolphin's sounds had to be slowed down in order to make them intelligible in the "Donald Duckish" voice he called the "dolphinese" accent (Lilly, 1961: 144-53). He also accepted difficulties that the dolphin's loudest and most varied sound production occurs in water, and humans in air.

> The air-water boundary is a very real and difficult interface for either us or the Cetacea to cross so that we may meet one another halfway. If they are to meet us in air we must furnish them with 'flesh-conduction' earphones so that they can hear us in air. If we are to meet them in water we must be furnished with some means of talking underwater (Lilly, 1961: 96).

The closest he seemed to get to this idea was a working method whereby

> I placed in the tank an underwater loudspeaker connected to an air microphone so that he [dolphin Elvar] could hear our voices no matter what we were saying in the laboratory and get used to the sounds produced by humans. We also had in the tank a hydrophone connected to an air loudspeaker so that we could hear all of his sounds (Lilly, 1961: 144).

Finally, he gives a description of the "voices of the dolphin" in which he lists the kinds of sounds they naturally make, such as "clicks, creakings, whistles, squawks, quacks, and blats" (Lilly, 1961: 151), and the kinds of sounds they produce that appear to imitate human sounds, such as laughter, whistles, 'impolite noises' and even human words.

This work on interspecies communication with dolphins was taken up in 1966 by Bateson. He first published the essay "Problems in Cetacean and other Mammalian Communication"

while working with Lilly at his dolphin research centre (Bateson, 1972: 364 – 78). Perhaps in a way of deferring criticism about his interest in Lilly's controversial work, he clearly states his angle on the topic: "The point is not either to discover that dolphins have a complex language or to teach them English, but to close gaps in our theoretical knowledge of *communication* by studying a system that, whether rudimentary or complex, is almost certainly of an unfamiliar kind" (Bateson, 1972: 365).

The central problem of understanding cetacean communication lies in the difficulty of approaching communication that may have completely different goals and importance. Bateson draws on behaviours of terrestrial, non-linguistic mammals, such as the wolf and the domestic cat, to describe the predominance of communications of relationship (love, hate, dependency etc). In such communications there is no need for a language of data such as humans have developed; humans have hands and manipulate objects and language, according to Bateson, is built out of this ability and necessity. The communication of relationship in humans is, according to Bateson, less explicit in language but can be found in gesture, termed proto-linguistic communication, common to all mammals. As they do not use objects, cetaceans, Bateson proposes, are almost solely communicating issues of relationship. However, unlike land-based mammals they have very little in the way of visible gestures as facial expression, body hair and limbs are all smoothed in underwater life where vision is strained. It is not only almost impossible for us to guess at their proto-linguistic meanings, but dolphins themselves must have developed alternative ways of communicating – most probably through their complex sounds. He goes on:

> I personally do not believe that the dolphins have anything that a human linguist would call a 'language'. I do not think any animal without hands would be stupid enough to arrive at so outlandish a mode of communication. To use syntax and category system appropriate for the discussion of things that can be handled, while really discussing the patterns and contingencies of relationship, is fantastical (Bateson, 1972: 372).

But what then is the meaning and function of their enormously complex acoustic soundings? Is it necessary for communicating about relationship? Does it form a different kind of language altogether? Or is it closer to what humans call music? Going further, Bateson distinguishes between what he calls analogue and digital in communication. Human language could be considered mostly a digital communication system, where signs may express but do not contain magnitude in themselves, "the word 'big' is no bigger than the word 'little'" (Bateson, 1972: 373). But the analogic system of proto-linguistic gesture or behaviour expresses magnitude directly in matters of degree, a muscle can be more or less tensed, a

smile more or less intense. The analogic system of gesture is more intelligible across cultures, and recognisable in terrestrial mammals, than is the digital system of human languages. And yet, Bateson claims, on listening to the dolphins sounds, he cannot comprehend much analogic communication that he would recognise in the cat or wolf. Perhaps dolphin communication through sound is another digital system, but one more concerned with questions of relationship than human language? "This system is something we terrestrial mammals cannot imagine and for which we have no empathy" (Bateson, 1972: 374). How can we then study and potentially understand this communication "which might, more probably, resemble music" (Bateson, 1972: 374)? And if it does resemble music, then we are still left with the question of what music communicates.

What then is music in relation to these ideas of inter-species communication? In a recent interview published in the *Soundscape Journal for Acoustic Ecology*, Dunn proposes that "it's a way of keeping alive a modality of communication that we share with other forms of life" (Miller, 2007: 16). As inspiration and support for this theory that underlies his work, Dunn cites Bateson on dolphin communication described above, reiterating the cybernetician's point that it has very little to do with human language "the only thing he could relate it to, in terms of human experience, was music" (Miller, 2007: 16). His second example of music as paralleling non-linguistic forms of communication shared with other species, is the previously described work of André and Kamminga, collaborating with West African drum master N'Daye Rose, to investigate the polyrhythmic communications of sperm whales (André and Kamminga, 2000). As we have seen, in this example the opinions of an expert musician opened up possibilities for the scientific team to explore otherwise indecipherable meshes of clicking sounds from a group of sperm whales. Echoing Lilly and Bateson, Dunn says, "Much more is being communicated by the complexity of this [non-linguistic] modality of communication than we have usually dared to imagine and that is something that musicians can relate to and talk about" (Miller, 2007: 16).

The possibility of inter-species communication with cetaceans, particularly through the possible closeness of their sound to human music, has recently been revisited by Rothenberg who explores clarinet improvisation with whales of different species. In his book *Thousand Mile Song* (2008) Rothenberg maps a history of whale song and scientific explorations into the world of underwater sound in relation specifically to cetaceans. In his own musical improvisation with whales he relies on fundamental notions of musicality that are specific to humans. In doing so, his approach to exploring the relationship of music to the sounds of another species must be questioned.

The *Leonardo Music Journal* published a paper by Rothenberg specifically about his improvisations with humpback whales, entitled "Whale Music: Anatomy of an Interspecies Duet" (Rothenberg, 2008: 47-53). Using an underwater loudspeaker to broadcast his clarinet improvisations beneath the sea, he attempted to "try interspecies jamming with humpback whales". He claims that "this chain of technology enables the clarinetist to talk to the whale or, more accurately, use music to cross species lines. Why do I think this is even worth trying? Because music can communicate across cultures in a way language cannot" (Rothenberg, 2008: 47-53). Although he appears to echo the reasoning of Lilly, Bateson and Dunn, Rothenberg's motivations, methods, results and conclusions are entirely different. He goes on to say, "I would essentially be interrupting a reverie whose purpose we do not know. In the musical moment I did not care about the purpose, but instead wished to understand the result" (Rothenberg, 2008: 49). But of what value is the result if founded on 'not caring' about the foundations? Rothenberg's paper is full of assumptions that amount to an imposition of human music on whales.

Why does Rothenberg assume that a whale will respond in duet form? There is no evidence that whales 'sing with' or respond to each other over short time-spans, despite the fact that their song evolves. They must listen to each other but it is not thought that they enter any communicative back-and-forth of sounds or call and response within their songs. Rothenberg mentions that another whale singing at a distance of one kilometer, is likely to be more important to the near whale than clarinet sounds. When he writes, "we really seemed to be listening to each other" (Rothenberg, 2008: 49) he refers to a musical notion of 'listening' in improvised music, where the result of some level of communication between the players is particularly poignant and tangible. He implies that there is a possibility that the whale recognises this musical idea of 'coming together' in improvisation, an assumption based on a specific genre of human musical techniques. Indeed, would free jazz improvisation even be recognised or understood as 'jammable' with by non-Western musicians, let alone another species?

As discovered by Payne and McVay, and referred to by Rothenberg, the structure of whale song lasts up to thirty minutes and a session may last many hours. The four minute excerpt that, according to Rothenberg, demonstrates some hint towards inter-species communication or 'jamming', does not equate with the different temporal song structures of whales and humans. Building on Payne and McVay's use of spectrogram visualisation, Rothenberg illustrates the moments of greatest confluence, but without the larger structure it is hard to tell if the whale is changing its song in response to the clarinet or repeating its

themes and variations to which the clarinet is responding. To substantiate Rothenberg's claim an overview of the structure of the larger whale song, combined with an analysis of it in relation to the whales time-frame is necessary.

Further questions dispute Rothenberg's approach and conclusions. Why would the whale respond to (clarinet) interference occurring within a small band of its frequency range and at relatively low amplitude levels in comparison with its own sound? Why assume this is experiment and not harassment? The whale is approached by the boat, not the other way around. The clarinetist humorously mentions that "the aiding and abetting of musicians who try to harass whales by playing amplified underwater clarinets to them is against the U.S. Marine Mammal Protection Act of 1972" but he does little to argue why his own work is other than harassment. His conclusion suggests a strange arrogance, when the "highest compliment an interspecies musician could receive" would be to influence the evolution of the humpback songs. He hopes that what he has learnt from whales will be mutually influential.

5.12 Underwater Sound in Scorescapes

This research into underwater sounds and cetaceans has been influential to my work in numerous ways. *Pink Noise, Fishing for Sound*, *An Image of the Sound of a Dolphin Echolocating* in *Scorescapes Spectrograms, Ponce Inlet, Swim* and *S.W.A.M.P. 1, 2 & 3*, all revolve around what I have learnt through this research. I experimented with making hydrophone recordings in a number of situations, and exploring the interpretation in sound compositions, spectrogram images, audio-visual installations, audio-visual performances and group improvisations. Learning about the sonic characteristics of underwater helped me in creating works that embraced the particularities of this unusual environment. For example, the audio-visual installation, *The Pink Noise of Pleasure Yachts in Turquoise Sea* (2010), and performance, *Fishing for Sound* (2010), exemplify my artistic approach to absorbing the complex topic of underwater sound into a perceptually immersive (rather than didactic) experience, while emphasizing the importance of making the inaudible audible.

In *Pink Noise* I experimented with hydrophones to question our access to and influence on the underwater environment. Recorded in a national marine reserve in Spain, the work reveals the unearthly anthropogenic sounds of pleasure yachts set against an idyllic moving image of the surface of the environmentally protected seascape. Conceptually more complex, *Fishing for Sound* presents a plethora of spatial connections between phenomena

underwater, in the mind, and from outer-space. The performance weaves sounds from scientific analysis of marine environments, sounds used in psychological treatment for post-traumatic stress disorder, and sonified data from satellites orbiting the Earth. All share in a mass of background noise, sounding in the contexts of environment, memory and information. Listening in these spaces is like fishing for sounds. These works will be discussed in greater detail in the chapter seven, to emphasise their relationship to the breadth of concerns of my practice.

Through the process of making *Pink Noise* and *Fishing for Sound,* I recognised the central importance of considering the *context* in which sounds occur rather than exclusively the qualities of a sound in itself. For example, *Pink Noise* and *Fishing for Sound* present a wide spectrum of sounds recorded underwater with barely any post-production editing or isolating of individual sounds. The effect is a very dense sonic texture reminiscent of how one may actually hear it in the field. This is in contrast to many field recordings recorded and edited for artistic purposes which typically proceed by splitting up the soundscape into isolated sonic events. That standard editing approach, combined with playback in a location different from the recording, effectively isolates the sound from any suggestion of its original context, an issue discussed in detail in the following chapter. Yet in working with environmental sound an understanding of its contextual nature, in terms of spatial acoustics and interaction with other sonic ecologies, is crucial, as exemplified by the works of André and Lucier discussed in this chapter. This insight also builds on LaBelle's notion of the 'relational' quality of sound (LaBelle, 2009), where sounds can only be understood in relation to the broad environment in which they occur.

Through works such as *Pink Noise* and *Fishing for Sound* I offer alternative answers to the question as to what extent such notions of a relational, contextual and embodied approach towards sound in the environment, can extend into physically inaccessible environments such as underwater. By researching the salient characteristics of underwater sound and considering the use of sound as 'sonic evidence', my analysis of whale sounds hopes to reveal contrasting and complementary ways of interpreting and understanding underwater sound through the overlap of practices of music and science. Rather than attempting to directly interact with whales, I propose developing a heightened sensitivity to an embodied experience of sound in specific environmental contexts. This perspective offers a more productive approach towards understanding the immersive experience of underwater sound. The works discussed in this chapter lead away from a certain anthropomorphising of whales, understanding them in terms of human song and musical structures, towards an

immersion in the sonic process, medium and context the whales inhabit. This immersion in sound may lead to more embodied approaches to understanding and exploring underwater sound both in the arts and sciences.

It is clear that the scientists are influenced by music, and composers by science, but what can be learnt from the comparison beyond this rather superficial observation? By placing these works next to each other, and developing my own artistic works as part of the research process, they resonate together and offer new perspectives on our methods and relationships to the underwater environment through sound. The overlapping interest of scientists using musical metaphors for interpreting data, and composers exploring scientific and acoustic properties, raise important implications for composers, sound artists and sonic ecologists working today.

6. Field: Place and Embodiment in Field Recording

6.1 Issues in Field Recording

The practice of field recording is a fundament of a variety of disciplines, and is used by scientists, acousticians, sociologists, anthropologists and musicians. The word 'field' as used in field recording has a number of interpretations. The name originates from the need to collect data, information, and conduct experiments, outside of the institutional research base, laboratory or gallery, and is related to 'field work'. As mobility is central to these needs of moving out into the environment, field recording develops in tandem with the technology of portable high definition audio recording equipment. A field can also refer to layers of sound, energy fields, gravitational fields, magnetic or electromagnetic fields, data fields, and general overlapping areas of effect in space. Or in an even more abstract sense, it can, as art critic John Berger describes, be understood as state of mind. Following Berger, in my own work I have been exploring a literal country field as a starting point for re-thinking the field recording into an active form of listening.

While the motivation and methods of analysis are clear for most of these diverse practices, musicians set their own criteria and have explored many different, often contrasting, approaches to recorded sound. What do we do with these environmental sounds in a musical context and how are they treated in relation to musical material? As will be discussed later, two distinct approaches are either to use the sound recording as a source of abstract sonic material for a composition, or to highlight the original source of the sound and explore this in relation to musical or instrumental sound.

Field recording potentially opens relations to environment that previously have not been explored because of the preconceptions about environmental soundscapes as providing interesting musical material for subsequent composition. But on further reflection it is not convincing that field recording in itself has anything to do with musical materials and constructions. The musical use of field recordings is merely one interpretation of sound and environment, and limits the possible interactions and knowledge about these environments through the artistic process. Is it possible to get beyond a relationship with these sounds as objects to be manipulated and stated in a compositional setting? Can field recordings do more than function as an empty reference to a distant, exotic or wild place? Listening to field recordings is potentially a key to understanding the feedback loops in ecological systems, between ourselves and the environment (see chapter four, Dunn and Crutchfield, 2009), but

we need to question and re-formulate what and why we listen-record-listen, and what happens when we replace, displace and remotely act on sounds of environment.

The field recording, considered in terms of music and sound art, provokes a particular set of questions about how we use this form to relate to environment. The apparently simple process of recording sounds from a chosen environment and replaying them in another place and time, yields important insights into the use of technology, the conceptual replacement and displacement of place and time, and our passive or active engagement in a site through its sound. Most importantly, the field recording, more than just documentation or potential musical material, actually opens up ideas about the relationship between place and listening itself.

Most art work engaged with the environment sets up tensions between the actual site of the sound/image source and the site of its (re-)presentation, the location and the gallery or concert hall. Drawing parallels between field recording as Sound Art and practices of Land Art offers insights into these issues. The walks of Richard Long, or Robert Smithson's *Spiral Jetty* (1970), came back to the urban gallery in the form of photographs, films, maps and documents. Smithson's concept of 'Site/Nonsite', developed in the late 1960s, explicitly challenged the predominance of the gallery and created a dialectic between gallery and environment, by dealing with "these aspects in pairs, two variables functioning as each other's opposites" (Bijvoet, 1997: 96). In a similar way field recording has always set up a tension between 'there' and 'here'. The soundscape of a chosen place is recorded, taken away and played back in a different place. In most cases field recordings are listened to at a site other than the source of the sound. In fact the whole practice and technique of field recording is founded on its portability, and the concept of an ideal listening space elsewhere. Recordings listened to over the internet make an even more distributed audience and distant, unpredictable relationship between the place of listening and the place being listened to. So the act of recording and the diverse circumstances of listening, given current technological developments of communication networks, is becoming increasingly complex in how it relates us to environment.

These concerns raise important questions central to the practice of field recording as sound art, and our assumptions about place, context and portability. The bias of the 'here', where we listen to the playback, over 'there', where the recording originated, usually makes us think of what it means to hear this soundscape from a dislocated place. When listening we must question how unusual it is, how much we recognise, and what supplementary information is needed to understand it. Building on the research presented throughout this

dissertation and the concern with creating embodied understandings of environment through sound, I propose turning these assumptions of questioning around and asking: How does or can my listening to this recording influence the original site of the recording itself? Is it possible to consider and instigate a more radical feedback system between the specific characteristics of a recorded site and its distributed listening sites?

Berger's meditation on a country field describes the provocation of a state of mind, of interconnected events and of the activity present in apparently static/passive time, 'in the now', in a way that "displaces awareness of (our) own lived time" (Berger, 1971: 74). Listening to a soundscape is much the same, as one is presented with a space created by sound, with identifiable sonic features, where certain characteristics are prominent. This leads one to the idea of the listener as central, as the spatio-temporal locus of a perceptual event. The event of the field, in Berger's sense, can only happen in the context of the site, that is, in the particular acoustic 'field' of a listener/viewer. Is it possible to generate or sustain the same possibility of Berger's state-of-mind in a playback space displaced from the original context? Can the presentation of a field recording be used to create such a 'field' of mental space in and of itself?

This implies complex, shifting relationships between place and listening. Place and listening are present in both a recording, and a site being recorded. Importantly, field recording suggests and enables a *movement* of relation between place and listening, reminiscent of Smithson's Site/NonSite already mentioned, and therefore encourages multiple versions of that relationship. If we practice the same listening techniques on both unrecorded and recorded sound, we must find ways of distinguishing the difference. This places the emphasis on the listener and how techniques of listening can potentially invigorate the use of field recording in sound art.

6.2 Questions of Place: the Composer and Field Recordings

Because recordings emulate actually occurring sound waves, the actual events - or rather, our imagined constructions of them - are foremost in our minds when listening to them. This kind of reasoning is similar to the suspension of disbelief that forms the basis of cinema, wherein the viewer is complicit in a kind of sensory tricking (Chion, 1994). Because it sounds the same we therefore conclude that it is the same on a certain level, and suppress or overlook the questions of context that are fundamental to this experience. The desire and ability to transport oneself through this medium to another place, which is helped by

closing one's eyes to suppress the contradictory surroundings of the playback space, provokes an intense listening focus that is different from our everyday. Because the sounds are isolated and concentrated, removed from the physical experience of their context, we become hyper-aware, in an abstract, analytical, perhaps musical way.

In *Background Noise*, LaBelle deals with these questions of place in environmental sound recording. In the 1950s Pierre Schaeffer used sound recordings of all types to create *musique concrete*, advocating his idea of the 'sound object' that emphasised the removal of audible reference to the original source of sound. LaBelle writes, "As Schaeffer discovered, sound's potential existed not in its immediate, real instant but in its separation from such a location." (LaBelle, 2007: 27) This remains a dominant aesthetic approach to the treatment of field recordings in sampling and live-sampling techniques, which are used as a source for abstract musical sound composition and improvisation. LaBelle also defined what he called "reduced listening", focusing closely on sonic elements so that one notices their timbres and envelopes in a kind of abstracted mode akin to focused musical listening. This ideal spawned a form of listening that reduced any external stimulus, demanding playback spaces with high fidelity sound systems and darkened ambience. He describes the inevitable consequence of the 'acousmatic' tradition of listening in a darkened space to a multiple speaker playback system with the aim of heightening the pure experience of the sound itself, as a "suppression of context", and a decision "to break the contextual link" (LaBelle, 2007: 30-1).

LaBelle contrasts this tendency with the Acoustic Ecology movement that emerged in the 1970s. R. Murray Schafer describes this project as follows:

> Ecology is the study of the relationship between living organisms and their environment. Acoustic ecology is therefore the study of sounds in relationship to life and society. This cannot be accomplished by remaining in the laboratory. It can only be accomplished by considering on location the effects of the acoustic environment on the creatures living in it (Schafer, 1977: 205).

As LaBelle notes, "Schaeffer and Schafer thus occupy two extremes on the sonic spectrum; one strips context and the other emphasises it," (LaBelle, 2007: 209) and he gives a sympathetic but ultimately critical view on the somewhat utopian aims of the group to bring awareness, education, analysis and activism to sound in the environment. He identifies "a seeming nostalgia for the primary sound" (LaBelle, 2007: 204) and unwinds the contradictions in the recording, preserving and replacing of locations through sound. Going further with this issue of context LaBelle writes "as a listener I hear just as much

displacement as placement, just as much placelessness as place ... difference and displacement form a backside to soundscape compositions' emphasis on emersion and origin" (LaBelle, 2007: 204). By highlighting the poles of musique concrète's sound object, and Acoustic Ecology, LaBelle successfully gets to the core of the contradictions between place and listening in field recordings.

His main critique of Acoustic Ecology lies in their "seeking universal truths" (LaBelle, 2007: 218) for example the idea of noise, and therefore noise-pollution, that noise is unwanted and should be eliminated as much as possible. This, for LaBelle, constitutes a value-system that excludes other possible approaches to environmental sound. Using sound artists Yasunao Tone, Bill Fontana and Janet Cardiff as examples, he builds alternative discourses to the predominant Acoustic Ecology model. "… [S]ound stands out by enabling such intermixing: by bringing place out of place and toward another, embedding the original on media while accentuating the real" (LaBelle, 2007: 218). The most valuable part of this discussion is in the synchronicity of the senses, as a potential in the intermixing of the real and virtual, the displacement and overlapping of location. Far from the acousmatic model of listening this hybrid form includes other senses and plays at the edges of perceptual understanding. This perceptual activation through sound has been central to my work as is discussed in relationship to my work with walking in detail in the chapter three.

6.3 Listening to Recordings: Schizophonia, Real/Virtual, Body.

The field recording, far from a presentation of the 'truth', is a mediated form of listening. This relationship between the real, and the virtual and our perception, manipulation and presentation of them is acute when the environment is recorded. Using a real space to create a virtual space through recording technology, Schafer theorised the splitting of sound from its source by using the term 'schizophonia' (Schafer, 1977: 273). Recorded and transmitted sound displaced from its original context gains new contexts, and so becomes a form of environment in itself that we listen and navigate through. We have to be able conceptually and psychologically to orient ourselves in mediated sound that we hear from digital networks, radio and telephone. We are increasingly habituated to this new norm of mediated sounds, disembodied voices, sounds that have no directly observable physical origin, or have no specific time in themselves existing in a stored medium accessible at any time. But in parallel with this development the here-and-now of walking down the street has become a neglected part of our experience. The technology of recording and transmission,

has provoked a split dissociating hearing from the functioning of our bodies, and in doing so removed our attention from actually listening to our immediate environment. We are listening in both a removed place and a removed time, experiencing a complex dislocation, a disassociation between a natural environment and a mediated environment. So, while gaining abilities to exist in parallel temporal and spatial environments through communication media, our basic phenomenological abilities are challenged to expand.

6.4 An Informed Listener or Sonic Colonialism?

Pierre Schaeffer's advocacy of musical listening, and Murray Schafer's informative, educative and environmental approach to sound recordings demarcate a fascinating aesthetic distinction. On one extreme there is the tendency to deny the environmental source of the sonic material used in composition (Schaeffer) and at the other extreme to deny the displacement and artificiality of the recorded environment when played back out of its original context (Schafer). However, both ask the listener to train their musical ear on a natural soundscape. This musical approach leads to the question, is there such a thing as an 'unedited' field recording? Even creating the most basic recording involves an editing process, including choosing the location and time of recording, a choice of microphones and their placement, followed by the subsequent selection of a specific section, and even such minimal studio edits as cross-fades between each recording. (For a simple introduction to this process see Dunn, 1999: 21-4). The use of compositional choices means that even in the most 'raw' field recordings, the boundaries between presentation and composition are questionable.

As already stated, field recordings rely on and imply their location and this fact is either considered musically irrelevant (extra-musical), or critical to interpretation. Many works with field recording fall into the trap of embodying a strangely counterproductive contradiction between the preservation and exploitation. On the one hand field recordists support the preservation of an endangered environment by bringing its soundscape into awareness in a distant location. On the other hand the decontextualisation of this environment forces us to listen in an aesthetic mode of consumption rather than in an empathetic mode of environmental understanding. At its worst, listening at a distance to a field recording can induce what may be likened to a feeling of ownership over the place, a confidence in a pseudo-understanding of a distant location, what one might call a 'sonic colonialism'. When listening to field recordings, or music made from them, what sort of

subject position should we as listeners take as a starting point? What is our relationship to the recorded sounds, the place from which they originate, and the place in which we hear them? What is our responsibility to them?

This ambiguity is often difficult to address in performance. A spoken, written or image-based introduction to the location before performance does not necessarily solve the problem. One example is a recent presentation I attended in Amsterdam by sound artist Fransisco Lopez of recordings from the Mamori Sound Project, Amazon Brazil (Lopez, 2011). The strange and deeply rich sound world is largely unedited as Lopez emphasises the critical importance of the recorded location of the rainforest. At the same time however, he holds back information on the actual source of the sounds – what kind of bird or insect - asking the audience to first listen and ask questions later. He asks us to listen to the sounds themselves in a kind of musical, associative way, rather than in an analytical or informative sense. But is this enough, or do we need more information, and if so, of what kind?

On the one hand it presents an environment that we do not know and have not heard before, and at the same time holds back the information that we would need to understand this place. Aware of this problem, Lopez supports this decision by drawing parallels with the fact that the source of most sounds in the rainforest are hidden from view. This is equating the ability to see the source of the sound as the way of understanding the sound, but what do we actually learn from the sight of a tree frog in relation to its sound? Beyond the basic labels, frog, bird etc. that are confirmed by the sight of the source of the sound, there are other bio-acoustic ways of understanding and listening to these sounds themselves and their sonic relationship to each other, that inform us more about the ecological balance of the location. Lopez's approach is in contrast to Dunn's in that he consciously separates his scientific expertise as an entomologist from the motivation and interpretation of his recordings. By doing this he limits himself to a traditional role of a musician, rather than opening up modes of understanding and researching the environment through sound as Dunn does in his work.

6.5 Field Recordings, Anthropogenic Sound and Bio-Acoustics

Basic bio-acoustic definitions provide an alternative and complementary way of understanding structures in environmental sound. *Biotic* (biological, animal life), *abiotic* (environmental sounds such as wind, water), and *anthropogenic* (human induced) sound are the basic makeup of most soundscapes. The balance between these three is a crucial

indicator in assessing the ecological balance, and therefore the health and sustainability, of an environment. As discussed in chapter five, the dramatic increase in anthropogenic sound in the oceans over the last century, and the lack of protective measures against sound levels and frequencies, has created an alarming disturbance in the ecological balance of underwater life, the effects of which are beginning to be measured scientifically, and which may, in many cases, be irreversible (Stocker, 2002; Slabbekoorn, 2010). And yet most field recordists will avoid anthropogenic sound, often editing it out, in search of the 'pure' but unreal version of an environment.

There are instances, however, where anthropogenic sound merges in a balanced way with biotic and abiotic sounds. Dunn's recordings in *Why Do Whales And Children Sing* (1999) illustrate this point, as does Hildegard Westerkamp's classic composition *Kit's Beach Soundwalk* (1989) and Annea Lockwood's *Sound Map of the Hudson River* (1989). Westerkamp's composition specifically introduces the capabilities of altering the perception of sound via the technological process of editing. The composer's voice narrates this editing process taking the listener from a location on the beach to dream worlds inside the composer's head, through the transformation of the sounds. Technology is accepted as a central part of the process of field recording and is brought to the fore through this treatment. This is an approach that I take further in my own work, allowing the technology to be subtly audible or visible, to acknowledge the presence of technological intervention without intruding on the sense of immersion.

A further bio-acoustic principle used in the analysis and understanding of environmental sound, biotic sound in particular, are concepts of *frequency-sharing* and *time-sharing*. For example, in a group of frogs each individual will fill in the gaps between other calls rather than call at the same time. In terms of frequency, in a larger ecological system of insect bird and other animal sounds, different species will occupy different frequency bands, again in order to be heard within the overall sound. Termed the "niche hypothesis", and later "biophony", by sound ecologist and bio acoustician Bernie Krause (Krause, 1998), it is also prominent in the research of ecological scientist Peter Narins, expert in frog and amphibian sound including ultrasonic calls (Narins, 2009). Research of bio-acoustician Hans Slabbekoorn revealed a frequency shift in the bird song of Great Tits in urban environments, which have adapted to sing in a higher frequency band in order to overcome dominant urban sounds (Slabbekoorn, 2003).

Understanding these basic bio-acoustic categories and behaviours within environmental sound is only a beginning, but can provide a useful way into listening to field recordings. I

experimented with this approach in *Hydro* (Amsterdam 2009) and *SWAMP 1, 2 & 3* (New York 2009, Berlin 2010, New York 2011). This series of pieces used my field recordings in collaboration with improvising musicians. In rehearsal I introduced the musicians to bio-acoustic properties and behaviours, as well as larger questions of feedback loops and ecological systems, then played several of my own field recordings to them. The musicians all found musical familiarity with these theoretical structures in relation to traditions of improvised music. Rather than reacting to certain sounds, we developed a more coherent approach to embedding our sounds within a model of an ecological musical system we were creating in the moment. These performances suggest an insightful approach that combines field recordings with musical practices, integrating improvisation as a complex systemic environment of musicians, with the deep systemic structure of the soundscape and the environment from which it originates.

6.6 Field as a State of Mind

A field is a demarcated piece of cultivated land. Sound enters the field from within and beyond the boundaries, as does any other air-born thing such as pollen, insects, birds and weather. Animals, people, seeds, harvests, all enter and leave the field often in a transformed state. A field changes with the effects of seasons.

In his essay "Field" Berger describes a state of mind induced by the contemplation of an occurrence or small activity in a real field (Berger, 1971). It is a fleeting state of mind that is hard to capture or describe, something like a daydream as described by philosopher Gaston Bachelard in *The Poetics of Space* (Bachelard, 1958), but rooted to events within the boundary of the field. It is not a free-associating spin, but a concentrated distraction, a moment of noticing a slight difference within a bounded space. The homogeneity and overview of the field frames and contains the event, which in turn draws us into details and further events within it.

For Berger, the experience of a country field provokes this state of mind. Something similar happens with sound fields, where some slightly noticeable activity draws one deeper in to the sound. An activity too shocking, loud or unfitting will have the opposite effect. But again, the more one listens, the more one hears. Berger really describes the limits, the framing of the field or context, and the provocation into an altered state of mind that is for a moment in another time and space altogether, the effect is that it "displaces awareness of your own lived time" (Berger, 1971: 74).

In the same essay Berger writes "All events exist as definable events by virtue of their relation to other events" (Berger, 1971: 74) The Dalai Lama describes the Buddhist tradition of coming to realise the non-inherent existence of phenomena. To do this one considers that every thing, thought, person or phenomena exists in dependence upon other factors, in dependence upon its own parts, and as a conceptual thought in ones mind, described as 'dependent-arising'. "Dependent-arising refers to the fact that all impermanent phenomena – whether physical, mental, or otherwise – come into existence dependent upon certain causes and conditions. Whatever arises dependently upon certain causes and conditions is not operating exclusively under its own power." (Dalai Lama, 2006: 51) This interconnectedness of things through space and time, physical substance and mental thought, makes the apparently inherent concreteness of phenomena dissolve. Rather than thinking of a field in terms of something concrete and inherent, which constricts the idea of field, these ideas of the interdependence between elements within the concept of a field offers a more open viewpoint.

Buddhist philosophies and practices have been influential in some important sound work since at least the 1950's. Beyond Cage who was explicit about the influence of Zen Buddhism on his ideas and practice, we can quickly find influences in Westerkamp's sound walks, Lockwood's river pieces, Oliveros' Deep Listening practice and Eliane Radigue's compositions. Interest in the interconnectedness of phenomena are shared by other equally influential theories of the last century such as cybernetics and systems theory, and ecology and sustainability, as discussed in more detail in chapter three. These theories are notable in, for example, Tenney's stochastic music, Lucier's spatial feedback loops and Dunn's environmental interventions. It is beyond the scope of this dissertation to offer a detailed overview of the relationships between these fields, but its important to recognise the basic notions and extent of these complementary influences in sound art.

6.7 My Personal Approach to Field Recordings

Pink Noise, Fishing for Sound, Tropical Storm, Swim and *Field* consider an approach to field recording that activates our relationship to that recording, and therefore the place/environment recorded, in a physical, embodied manner. While I also work on activating field recording potentials on site 'in the field', it is important to engage with this difficult topic of activation/embodiment in gallery/urban/installation settings, as discussed in this chapter. As we have seen, the nature of field recording is that it is removed from its

source and played back in another space, inducing what I've called a sort of 'sonic colonialism'. So in my work I attempt to activate the gallery experience by the content of the material itself, the installation and editing, challenging the passive-consumptive attitude provoked by the genre of field recording.

All the installations are minimal - they study just one thing - to open up a space that is immersive and hypnotic. They try to draw the audience into a physical frame of mind and a temporal space rather than a narrative. I do not hide the technology but allow it to be quietly present if one wants to hear/see it (either by image/sound quality, editing, installation). While I do not want the presence of technology to intrude on the depth of immersion, I do want it to be acknowledged in the work as one of the core principles of field recording. All the works use sound and image together and explore their synchronization and our perception of them. A description of these works that explore alternative approaches to field recording, *Pink Noise, Tropical Storm* and *Fishing for Sound,* are described in more detail in chapter seven called Flare.

7. Flare: Charging the Space between Intuition and Technology

7.1 Flare

A flare is a signal of light – a contained explosion for signalling distress in an emergency at sea. It hangs in the air, a drifting fireball with a tail. A flare is also an explosion of sound up into the sky, a whistle and bang, a tone, a tail.

This chapter synthesises an array of ideas developed in the previous chapters, but taking a more personal turn. Extreme personal experiences during my research have had a marked impact on the theoretical and practical development of the Scorescapes project. Unexpected forms of artistic experimentation emerged from hunches and speculations that arose from reflections on both everyday circumstances and extraordinary situations. Extrapolations from these experiences, and the research and practice that followed from them, although not following a traditional academic methodology, nevertheless played a key role in shaping my practice-based research, which resulted in new art works and works in progress. Flare is therefore both a concluding chapter and a set of personal visions towards future research.

The rethinking of the musical score, as put forward in the chapter two, involves conceptualising it in terms of relationship rather than notational instructions, embracing the potential richness of interpretation that moves into the role of the participant. The environmental issues put forward in chapter three, includes building this sense of relationship found in chapter two in terms of the larger environment, in practical and embodied ways. Both of these chapters assert a greater role for active participation, imagination and interpretation through sound and the environment.

This chapter goes further by suggesting the role of mental processes and the sonic unconscious in building these relationships through sound. It considers clinical techniques using sound in psychotherapy and alternative approaches of Deep Listening and dream practice to explore this realm. Parallels can also be drawn between the necessity of making the inaudible audible (as put forward in chapters four and five) and this chapter's concern with revealing aspects of the unconscious through various techniques, in order to at least recognise, if not expand, the active mental role we engage with when listening and making music or interacting with the environment. The sonic unconscious has clear parallels with the treatment of inaudible sounds in terms of how we bring what we cannot physically experience into our conscious understanding. This process of tuning in to the unconscious

mind of dream states and folding it into the waking conscious mind is central to this aspect of my research.

The interpretations of context and communication, as the relationship between image and sound, and the role of technology explored in chapter five, can be pushed further with respect to perception and interpretation. The complex layering of spaces through recording explored in the previous chapter and the notion of field as a state of mind leads on to examples of using field recordings to create mental spaces that engage and embody distant environments. These ideas imply moving towards what I call a 'techno-intuition' that recognises the implicit coexistence between the interpretation and creation of meaning and the technologies we use to sense and know (and navigate through) our environment.
I first described this in relation to *Sun Run Sun*, "I'm working towards a hybrid between these two ways of knowing, between navigation through technology and intuitive embodied navigation – a techno-intuition" (Harris and Dekker, 2009). Flare as an illuminating explosion, violently disrupts assumptions about electrical energy used to create recordings and installations using electronics, and the contradictions and parallels between sound vibration and electrical energy, leading to potential ideas of sustainability in energy use for environmental works. I see the Flare metaphor as a trigger for a more close analysis and practice of these ideas. The combination of sound, image, signal, explosion and navigation, distress and help form the foundation of this chapter.

7.2 Explosion

In May 2009, during a series of performative walks with the Satellite Sounders at the Schirn Kunsthalle Frankfurt during the exhibition 'Playing the City' (previously mentioned), an accident occurred that had unforeseen yet profound influences on my subsequent research. The lithium-ion batteries of the Satellite Sounders, re-charging overnight in my hotel room, exploded and burst into flames. The exact cause of the explosion still is not entirely clear. This incident set off a chain of events, the most immediate being interrogation by police, insurance arguments with the hotel, the hotel's neglect in not sending for medical help, accompanied by security questions regarding why I had "home-made electronic devices" in my possession, as though I might be a terrorist, cleverly disguised as a media artist. In spite of this frightening and emotionally disturbing calamity, I proceeded with my scheduled performances the following day with the one spare battery that remained. I later learned of an interesting coincidence: John Cage was caught in a fire in the Frankfurt Opera, and

subsequently produced a series of drawings that explored his experience of the explosion and fire.

The effect of the explosion had enormous repercussions. One sudden and dramatic event led to a long and drawn-out process of recovery, embodying a temporal pattern that was not regular and predictable. Both the explosion and the shock that followed intensified my work and made me ask fundamental questions about my process and techniques. Subsequently diagnosed with PTSD (Post-Traumatic Stress Disorder), accompanied by many symptoms including chronic insomnia and acute travel anxiety (which made travelling for performances extremely challenging), I was forced to confront the power of the unconscious mind and find ways to access it in order to overcome this disorder. The slow process of healing involved various experiments with therapy, initially through the now-standard EMDR using sound (described in this chapter) and later by applying alternative approaches using sound and environment inspired by Pauline Oliveros. These practical researches and direct personal experiences refocused my energy leading to new directions of research and practice described below.

Important new research issues that arose were: the use of and interaction with technology as related to electricity, energy and ultimately sound; the effect of combining image and sound (the explosion) to create meaning (the flare); the use of sound in EMDR therapy and its relationship to mental reconfiguration of memories; the use of sound meditations in Oliveros' Deep Listening Retreat as a way to realign the mind with body and environment through sound; an intensification of dream work techniques; relationship with environment reconnected through the practice of navigation within the mind and memory. I will discuss these ideas in relationship to the works *Pink Noise*, *Tropical Storm*, *Fishing for Sound*, *Therapy for Future Flooding* and *Swim*.

A recent request to show the installation *Pink Noise* and performance *Fishing for Sound* at the Shedhalle in Zurich, curated by Anke Hoffmann and Yvonne Volkart, placed it within the context of an exhibition on sleep and dreams entitled 'Dump Time: For a Practice of Horizontality' (2011). These pieces were also selected for a program series entitled 'The Sonic Unconscious' (2011) at Issue Project Room in Brooklyn, New York. Without my being explicit in any descriptions of this work about my own background investigations with sleep and dreams, the curators sensed the under-side of the work. This interest has encouraged me to examine these ideas as part of the dissertation.

Pink Noise appears to sonify and visualise an underwater explosion: muffled, wet, brilliant and illuminating. One visitor referred to it as experiencing "sound flares". Through personal experience I began to see significance in the implications of traumatic events on mental reconfigurations and discovered the role of sound in this mysterious and important realignment of the everyday.

7.3 Energy and Sonic Vibration

I was forced to question the use, interaction and fundament of technology in my work, understanding it not as a neutral material resource for sound recording and production, but as related to energy. The explosion emphasised the fact that energy is not made and lost, but only *transformed*. The dangerously overloaded cells expressed the potential energy present in electronic devices and brought the reliance on an external power source to the fore. Although hand-held and portable, as is much current consumer technology, these instruments never in fact stand alone, but are dependent upon continually updated energy resources to function.

Taking this line of thought further, the Resonator expert workshop at the A/V Festival and University of Newcastle (2010) proposed that electrical energy and energy in general are a form of vibration, and therefore share a common aspect with sound itself. The sudden transformation of state symbolised by the explosion, from functioning controlled electrical energy that was the basis of the Satellite Sounders, into flames, chemical fumes and heat, illuminates the nature of this potential energy. It was these questions that I collaboratively explored at the workshop described by the organisers as,

> a procedural performance-workshop and idea exchange which investigates diverse artistic, materialist and spiritualist practices that converge around the importance of vibration as a means of making sense of the universe. Vibration is a phenomenon that affects all matter yet is also understood as passing beyond matter, affecting the soul. Resonator aims to investigate the points of contact, convergence and dissonance surrounding the scope of vibrations in different thought and belief structures through working with sound and related practices. (Allen and Scrimshaw, 2010)

Working in an open structure with diverse practitioners and theorists, including Jamie Allen and Will Scrimshaw (organisers), Martin Howse, Brandon LaBelle, Ryu Hankil and James D'Angelo, facilitated an opening-up of the use and conceptualisation of electronics in relation

to sound as vibration. Considering the low-level commonality of vibrational phenomena in sound and electronics encourages a more fundamental understanding of the nature of these materials. Rather than assuming that technology-driven sound is a given, this approach ties electricity and sound to sustainable energy issues within the environment.

7.4 Sound, Image, Perception and Technology

The contextual nature of sound draws in the spatial, the visual, the other senses, and the combinations of them, making it impossible to study in isolation. For example, the particular qualities of a space in which a sound occurs are described as the acoustic properties of that space (as discussed with reference to Lucier's work in chapter five). Similarly, a sound often refers to or implies an image or object as its source. In written musical traditions, sounds are encoded and reinterpreted through visual notations (the rethinking of the score was discussed in detail in chapter two).

Philosopher and social theorist Brian Massumi describes sensory experiments to isolate the individual senses, noting their internal reliance on other sense modalities for perception (Massumi, 2002). And Oliver Sacks reports research on how certain individuals with sensory deprivation develop the missing sense in unusual ways, such as the blind man who could visualise multi-dimensional structures in his mind's eye (Sacks, 2003). The general synchronicity of the senses in experience, and the dissolving of the traditional distinctions between art forms based on these senses, underlies my own interest in the combinations of sound and image in space. In my work I experiment with combinations of still and moving images and environmental and electronic sounds that highlight the process of active perception in the creation of meaning.

As previously described, this research began with a notion of investigating relationship to environment through sound. This grew directly out of my work and interest in navigation as a bringing together of environment, technology and ways of conceptualising that space through mapping. In *Sun Run Sun* I took this to the extreme of creating hand-held instruments (Satellite Sounders) that allow the participant to hear sonifications of satellite navigation data while walking. Unlike a useful, readable visual map, these sounds were abstract and drew attention to the *process* of navigating by juxtaposing electronic sounds generated by a changing array of satellites with the sound of the local environment. In doing so the work enabled participant experiences of a more revelatory, imaginative nature than a literal map could have offered, as suggested by the participants responses that form part of

the sound piece *Satellite Sounding* (2009) (quoted at length in chapter four). As I stated in the published interview on *Sun Run Sun,* entitled 'Aiming for Dead Reckoning':

> *Sun Run Sun* acts more as a provocation to let one's mind contextualise the everyday sounds and environment that we may not notice consciously. It gives a context, it forces a focus, it does this by adding to the total sound world but without claiming the attention of a piece of music to be listened to. Fundamentally the sounds make you ask questions of where you are and how you are moving and if your movements have any affect on the sound. Most people seem to expect that they will hear the movement of their position or location, but they primarily hear the movement of the satellites in orbit, which provokes a perceptual shift of perspective as the emphasis is not anthropocentric. I've said that navigation requires a correspondence between what one sees in the outside world and its representation on a map, and when this doesn't work one is lost. Likewise, the experience of sound is an internal process that influences the relationship between the self and the environment. Interestingly the use of sound in the Satellite Sounders often makes people comment that they see things differently... (Dekker and Harris, 2009: 52)

The synchronicity of the senses in relation to embodied ways of constructing meaning was explored in the recent exhibition, 'Esemplasticism: The Truth is a Compromise', curated by Hicham Khalidi at Club Transmediale in Berlin (2010). The term "esemplastic" refers to the shaping of disparate elements into a unified whole, and the exhibition demonstrated how multi-sensory experiences provoked by combinations of artistic media draw our attention to the ways we perceive the world. Khalidi addressed "different facets of perception in the fallout of the information revolution; each of the works lays bare the tricks and techniques used by our brains to negotiate the 'objective' world against a historical backdrop of what OpArt curator William C Seitz, writing in the 60s, referred to as 'perceptualism'" (Khalidi, 2010). One of the catalogue essays claimed that the work in the exhibition "demands forms of embodied perception of physical and multisensory phenomena and provokes enigmatic quandaries that push the limits of consciousness as a phenomenological experience" (Shanken, 2010: 35).

My sound and video installation *The Pink Noise of Pleasure Yachts in Turquoise Sea* (2009-10) was exhibited in this context. *Pink Noise* is part of the *Scorescapes* series, which includes *Tropical Storm*, *Bell Buoy/Ponce Inlet*, *Field*, *Swim* and *Sail*. Building on the experiences of *Sun Run Sun* described above, these works explore the ubiquitous technological split that mirrors the senses of sight and hearing, by keeping distinct the camera-video-projection and

microphone-sound-loudspeaker as my materials. I experimented with different configurations of spatialization and installation in exhibition spaces to provoke blending of the two parts (visual, sonic) in the mind of the visitor into combined meaning. In each piece I make the presence of the technologies subtly manifest rather than hidden as a reminder of the constructed, displaced and technologically mediated nature of the exhibited environment. In general, my use of image and sound together attempts to foreground the sound in order to make one see differently. Rather than making the image the driving element of the work, the sound is equally prominent and the combination creates a dynamic experience that is multi-sensory. The role of technology in facilitating this split is central to our experience of image and sound in environment. *Pink Noise* and *Tropical Storm* are practical illustrations from this perspective.

7.5 Sound Flares: *Pink Noise*

Pink Noise is based on sound I recorded by a hydrophone underwater at a national marine reserve on the coast of Spain in midsummer 2009, not long after the explosion. Looking down through the surface of the water, through layers of reflected light, one could imagine that the underwater world is silent. Lowering the hydrophone beneath the idyllic surface of the water I was surprised by the intensity and variety of technological sounds - loud thumps, grinds and high-pitched tones from boat engines, anchors and depth sounders. The contrast between the view above and the sound below, and the knowledge of the significant impact of anthropogenic sound on marine life (discussed in detail in chapter five), was startling. The process of making these sound recordings highlighted the necessity of technology to make this otherwise inaudible environment audible. Using the hydrophone, sitting on the deck of the boat I could see above the surface but hear through headphones the sounds beneath. I was struck by my extension of the sense of hearing underwater and the new meaning it gave to the environment I was inhabiting.

It was these contrasting qualities of the view above water and sound below that I incorporated into the physical installation. I juxtaposed hydrophone recordings with a video projection of light through layers of water from the same location. To emphasize the technologized relationship between the experience of underwater sound and the surface image, the video is projected onto the floor with headphones hanging from the ceiling. One has to physically move into the piece, stand literally in the image of the water and bend down towards its rippling surface to reach for the headphones, thus making an embodied

connection between sound and image. The headphones encourage a sense of intimacy, privacy and focused immersion. The isolation and split between sound and image are brought back together by body and imagination.

I would like to contrast two descriptions of *Pink Noise* that illustrate these points, firstly from the perspective of a theorist, and secondly from a visitor to the installation. The exhibition published a collection of theoretical essays on the topic of 'esemplasticism'. Shanken's essay describes *Pink Noise* well, in particular the way that the installation provokes contemplations by blending sound and image into meaning, and is worth quoting here in full.

> Yolande Harris' *The Pink Noise of Pleasure Yachts in Turquoise Sea* (2009) explores the relationship between sound and image, making the inaudible audible while simultaneously presenting a visual corollary. 'Pink Noise' is a technical term for a type of sound commonly found in both electronic devices and in the statistical structure of all images of nature. Harris uses the term as a pun in the ironically saccharine title of her sound and video installation, which suggests the dark side of yachting. While the sun refracts with brilliant pink light that dances on the gentle, turquoise waves, high-powered marine engines under this elysian surface generate piercing otherworldly sounds (including pink noise) that are known to wreak havoc with navigation and communication among sea mammals, such as whales and dolphins. The viewer of Harris's work is placed in a perceptual enigma: Are the dancing pink sun and turquoise sea in the video projection responding to the yacht noises? Or has one's consciousness performed the act of synchronization on them? Although the sound waves generated by marine engines are literally present in the sea shown in the video (sadly, a national marine sanctuary in Spain), they cannot be heard without an underwater microphone (hydrophone) with which the artist recorded them and a sound system to amplify and reproduce them. Harris cleverly reveals the inaudible sounds of leisurely excess that permeate the sea, juxtaposing their haunting noise pollution with the natural beauty of the surface. In so doing, the artist not only questions the boundary between sound and image but expands our multisensory perceptual domain to include human and non-human perspectives. In *Pink Noise* we simultaneously see the sea as it is visible to our eyes from above it while we hear what the dolphins hear underneath the sea, including our sonic impact on that aqueous environment. (Shanken, 2010: 34)

The following transcript of an interview I conducted with a visitor, Flo, who experienced *Pink Noise* (with no prior knowledge of the work) illustrates these points from a different

perspective. She describes her thought processes while experiencing the installation (although her native language was German we spoke in English). Her conflation of the image and sound into one blended sensory phenomenon is summed up in her, to me remarkable, use of the term 'sound flares' to describe her experience of the work. The process of conducting such informal interview discussions with participants immediately after experiencing the work, while it is fresh in their minds, provides valuable feedback for my research and is a technique I have used on numerous occasions, including the aforementioned *Satellite Sounding* (2009).

> *I was intrigued by the way you stepped straight into the image and then stood very still. I couldn't see if your eyes were closed or looking down.*
>
> I was looking at the sound flares.
>
> *And what was your experience of it?*
>
> It was really like you stand somewhere outside, at one point I got the impression I stand outside at the seaside. I just felt with sound so much, connected to the light, so I thought I would like to feel it, its the same thing like we go to the sea after a long time and then the first time you see the water … and one moment it gave me that feeling ... but on a bit altered way, because it was like these kind of acute sounds, together with the light, really puts your concentration so much on the sea ... or ... light .. flaring to the water, so I really enjoyed it .. better than going to the sea.
>
> *That's really interesting that you call the light like flares.*
>
> For me it looked like light flares.
>
> *It's reflection on water ... kind of fire, kind of water. And the sounds? what do you imagine the sounds were? what was going through your head as you were listening to these sounds? did you imagine them coming from some sort of source?*
>
> No, actually I didn't see it as any kind of source at all. I just found it matched really well to the feeling of standing on the water, but I couldn't figure out what it is.
>
> *It's recorded underwater, in the same place as the video is recorded, underwater sound, in summer, in a marine reserve in Spain, it's sounds of engine noises from the yachts.*
>
> I couldn't figure out what it is but it suited very well to the image. Also it's not like you expect typical sea sound, but something really fits to the image. It sounded industrial though, but I was really spending a long time wondering what connects it because you cannot figure it out, its nothing like sea breeze or something. It something a little bit like techno. I got a feeling that it fits somehow exactly to the image.
>
> *I was really interested in that connection and trying to highlight that connection, with the headphones and ...*
>
> … what you hear underwater and see from the top?

> *... exactly ... and emphasise the kind of split as well, because they're different, you're not quite sure what they are but somehow they're connected , but without making it obvious what that connection is.*

Both of these texts describe the active effort it takes to experience *Pink Noise* and how that experience generates ideas about the relationship between image and sound. Playing carefully with this gap and the perceptions and expectations of participants generates an experience that is actively imaginative. Flo's term "sound flare" not only emphasises the synthesis of sound and image but names that image in relation to an incendiary device. In so doing, she suggests a connection between the work and the explosion I had experienced just months before recording the source material, at a time when I was deeply suffering from PTSD but had not yet been diagnosed. Indeed, in contrast to the "elysian" qualities of the "gentle," "dancing" surface noted by Shanken, Flo intuits a far more volatile and fiery aspect of the video, which she notes fits with the "industrial" and "techno" qualities she ascribes to the sound.

7.6 *Tropical Storm*: Re-living an Intense Environment in a Site-Specific Installation

Two weeks after the explosion in Frankfurt, I was in Florida at the Atlantic Center for the Arts where I experienced the intensity of one week of storms and floods in a tropical forest. The tension generated by noise, wind, driving rain and floods emphasized the psychological effects of environment. I was fascinated by the intensity and made the sound and video installation *Tropical Storm* (2009), consisting of a field recording of the storm from a static camera and microphone kept exactly synchronous.

Walking into a room of rain, a video projection of a tropical forest in a heavy thunderstorm, the fixed view camera presents a 7 minute 30 second section joined by a sharp single cut with no fade to a 4 minute 30 second section close-up view. The sound, placed in the space so the speakers face upwards and towards the walls to maximize its diffusion, is constant: loud in the first section and then suddenly very loud in the second section, like white noise with a broad spectrum and constantly fluctuating intensity that is directly visible in the video image. The two sections alternate in a continuous loop, so the viewer enters the space at any time and experiences a part of a tropical rainstorm.

To create the piece I made a full hour of video recordings over a period of several days. I then took this material into the black-box theatre and tried various versions on the four meter projection screen and sound system. Among the tests I tried out on the material was to separate the sound from the image, by playing one without the other, by superimposing sound from a different time onto the video image, by reversing the video and sound, by slowing down the sound and video together and separately. These experiments with the material - and specifically how they interact with each other - led me to choose these two particular sections only, with the most minimal intervention of editing possible. No zooms, no changes in speed or alteration of the synchronisation of sound and image.

What amazed me through this process was that the effect of the rainstorm lost all potency when the sound and image were pulled apart and re-juxtaposed. The high intensity of the sound is intensified further when corroborated by the image. The success of the intensity of this piece lies in the very fact that you are seeing exactly what you are hearing, and yet they don't repeat each other. The very fact of recording a moment in time and playing it back into another space at another time, isolates and highlights this combination of media in a very self-conscious way. The video image is only light projected, it is obviously only a recording of better or worse quality, and the sound likewise, but in their perfectly synchronized combination they develop a power that captures the essence of the thunderstorm itself.

Tropical Storm enables one to see and hear differently, concentrating on the flows and surges of rain on leaves, making all the surfaces resonate like a sound map of the surface of the jungle. It accomplishes this by demanding that one engage in a prolonged observation and listening of combined image and sound from a fixed view. At some points the rain seems violent, as if shot from a gun at high speed at the leaves which bend and give way under the pressure - and our ears take the same beating (a rapid succession of small explosions or sound flares?). The continuity of this high level of anxiety, fluctuating between the very loud close up section and the more distant section, is also notably hypnotic, even strangely soothing. Visitors to the exhibition often stayed for long periods of time, 30 minutes or more, and re-visited the work a number of times.

The premiere of this piece took place at the site where it was made, and the site-specificity and context generated an extra layer to the meaning of the work, particularly since most of the audience had personally experienced the torrential rains. When the storms stopped, the weather became very hot and humid, with mosquitoes hatching in large numbers and the swamp insects, animals and reptiles reappearing as the flood-waters receded. In this situation

the *memory* of the storm in the mind of the residents was distant, until replaced and reminded of its intensity by this installation. To step from heat, insects and sounds into a room where the same landscape is presented like a bottled up wet version of the same, contributed to the feeling of immersion into the memory of the tropical storm of the previous week. The space where I installed the work was a large, double-height cubic space with one wall floor-to-ceiling window looking onto the same dense swamp landscape. In the dark, with the projection on the perpendicular wall, its reflection in the window merges with the exterior view of the jungle at night, reinforcing this outside-inside play. In retrospect, after processing my own traumatic experience of the Frankfurt explosion, I began to wonder if this in some way acted as a therapy for the traumatic storm memories of some of the residents. Might it also have been a metaphorical dousing of the fire I had experienced and that haunted my own traumatic memory?

7.7 EMDR Clicks: *Therapy for Future Flooding*

Trauma in humans, as a psychological condition, is increasingly treated with sound. For example, the technique known as EMDR (Eye Movement Desensitization and Reprocessing), now the standard treatment for PTSD, uses clicking sounds moving from left to right once per second, listened to on headphones while recalling the traumatic event and associated memories from the past. The enormous success of the treatment is largely unexplained. The clicks either simply keep patients in the "here and now" preventing them diving back and reliving the past; or on a more fundamental psychological level they provoke bilateral stimulation of the brain that somehow helps in the reprocessing of these memories.

Related to bilateral stimulation in EMDR treatment, binaural beats are phenomena produced in the brain. Feeding one frequency in the left ear and one of no more than 30hz away in the right ear, produces a beating or rhythm in the brain which can be close to the frequencies of brainwaves. These sounds can be used to 'entrain' one's brainwaves to move to a certain state, to induce sleep, or meditation, or activity. Going further, sound stimulus can provoke electrical signals in the brain that can be monitored. These so-called 'auditory evoked potentials', measured by scientists, are found in humans and also in a wide variety of animals and undersea creatures, to measure their sensitivity to sound. These relationships between sound and brain activity were suggested by Lucier's use of EEG electrodes to monitor his brain waves during performance in *Music for Solo Performer,* described in chapter two.

My composition, *Two by Two: Therapy for Future Flooding* (2010) builds on ideas of EMDR and therapy techniques, provoking a subtle exchange between musicians and listeners, who all take an active role in the creation of the work. It was commissioned by Chris Kallmyer, sound curator at the art gallery Machine Project, for the Festival of New Music at the Hammer Museum at UCLA, Los Angeles (Machine Project, 2010). The available performance space was very small so the curators name it the Little William Theatre. This space could accommodate only two musicians and two audience members, and the commissioned work was to be 'site-specific' for this context. *Therapy for Future Flooding* is written for two instruments of the same kind, two participating listeners and mechanical pendulum metronome.

The musicians explain the interaction to the listeners simply before starting the piece, saying "concentrate on the sound and speak the first clear image that comes to mind. After this the other listener concentrates on this image and the sound and when ready speaks a new image that comes to mind. The first listener then concentrates on this new image and the sound and when ready speaks another new image that comes to mind. Progressively alternate in this way until the end of the piece." In a direct reference to the EMDR technique described above, the metronome, set to 60, is placed between the two players and two listeners so that the pendulum arm swings left to right. It starts and ends the piece.

The musicians alternate swelling sound textures to create a continuous combined sound that passes between them from stage left to right and back at every breath. Their sounds are a focused sea for the imagination of the listeners. The musicians explore the resonances created by the combination of their sounds, trying to smooth them together by subtly adjusting the envelope and timbre. They can also transform the parameters of the sound very slightly depending on the mental images being spoken by the listeners.

In terms of the scorescape described in chapters two and three, *Therapy for Future Flooding* is an exploration of relationship between the players and audience members who respond to each other's associative ideas. It plays with the gap between translations and interpretations, between two 'species' that speak different languages, confronting each other in a confined space. The response to the performance was of intense involvement and connection to the music, the players and other audience members, generating an intimate atmosphere and situation among the participants.

7.8 Tips for Dreaming: *Swim* and *Fishing for Sound*

In July 2010 I attended Pauline Oliveros' Deep Listening Retreat, a week-long residential retreat focusing on sound meditations, dream practice, group improvisation and Tai chi body practices. Oliveros describes the retreat form, begun in 1991, as "an evolving practice that comes from my experience as a composer, performer, improviser and audience member" (Oliveros, 2005). The overall experience attuned one to the rural environment and the other particpants. Particularly influential for me at this time was the dream workshop led by 'dream keeper' Ione (Ione, 2005). I had been consciously notating my dreams for many years, but had never worked in a systematic way in a group setting. I noted almost immediately the connection between trauma recovery and dream work, and related my experience with EMDR therapy as a more aggressive form of working with the mind to achieve similar results. The dream work enabled me to take control of the process of recovery and watch it develop day by day. The focus on sound and listening in dreams was a central focus of the retreat sessions and overlapped with the waking listening meditations led by Oliveros. It enabled me to more confidently engage with my own dreams and explore the processes of bringing them into wakeful consciousness, with the aim of integrating the two domains of consciousness.

At the Zurich exhibition on sleep and dreams, Dump Time: Towards a Practice of Horizontality (2011), discussed above, these thoughts led me to draft the short text, "Tips for Dreaming" with which I introduce my performance of *Fishing for Sound*:

> Always recall your dreams in the first person, present tense.
>
> This brings the dream thoughts into waking thoughts.
>
> Regularly recording dreams while awake, bringing them actively into waking consciousness, empowers the dream consciousness.
>
> When dreaming, try to realise you are dreaming, try to intervene in the unfolding events, try to participate in your own dream without waking.
>
> When you start to regularly see events from your dream world in your waking world, don't be surprised, or afraid, or dismiss them – prediction is totally normal!
>
> Our dream consciousness works on a different time basis, it is not linear.

Many people do not recall their dreams and few that do recall them focus much energy on drawing their dream consciousness into wakeful consciousness, integrating the two into a continuous field of awareness. The common dismissal of sleep and dreams has a parallel – what we see and hear and touch with our physical body is real, things we cannot perceive

have no reality to us. Our physiology limits our understanding of our environment. Like the inaccessibility of our dreams to our wakeful consciousness, many sounds occur in places and scales that we cannot hear – underwater, in space, beyond our hearing range – either too high or too low. Making these inaudible sounds and places audible brings them into our consciousness.

The underwater sounds in *Fishing for Sound* include insect, fish, dolphin and man-made sounds of engines, depth finders and anchors collected by a simple underwater microphone. In contrast, the electronic sounds come from satellite navigation data – sonified – or turned into sound to make it audible to us. These are tied together by clicking sound moving from left to right once per second, like the EMDR technique used in psychotherapy for curing traumatic memories. Although it is unknown exactly how this technique works, one explanation suggests that the alternating clicks act as a sonic guide through subconscious memories – a way of navigating through the mind. Similarly, looking through the viewfinder of a sextant, or listening via a hydrophone to an active anthropogenic soundscape beneath the apparently idyllic surface of turquoise sea, brings into consciousness elements of the environment we otherwise would not see or hear.

The thematic context of dreams and sleep in Dump Time suggested a new angle on my sound and video work *Swim* (2011). Indeed, the immersive first-person experience of swimming can be interpreted as a metaphorical dream: moving through water - an alternative reality to terrestrial experience – just as a dreamer journeys through the alternate reality of the dream-state. As a result of these considerations, I prefaced the viewing of *Swim* as though it were a dream:

> Swimming, I am floating on the surface. Aware that I am my own engine, my arms and legs propel me through the water. I am breathing regularly, in rhythm to my strokes, lifting my head from side to side to inhale air, which I slowly expel in a stream of bubbles beneath the surface. Cutting through the surface light, I see above water, then plunge my head below the surface looking underwater. On the boarder of the two worlds, propelling myself along the surface, rhythmically, something like walking but experiencing a suspension between two worlds. The sound on my ears rips through the surface, the bubbles rise loudly past my ears as I breathe out. My limbs and body are suspended and I propel myself forward through the liquid. I am merging into a sea of sound.

Moving beyond this intense first person perspective of the swimmer, caught on the surface between air and water, between dreaming and wakefulness, a greater distance can be drawn, a line between outer space, in the mind and undersea. Techniques of ocean navigation, traditionally involved observation of the sun moon and stars, weather and wave or current direction, and instruments like the sextant, which, combined with accurate time and astronomical tables, could be used to calculate position in an otherwise unidentifiable seascape. The present day GPS satellite navigation system, uses the same basic principle of triangulation, but connects to orbiting satellites greatly increasing accuracy, while decreasing the navigation skills of observation of the environment. In *Fishing for Sound* the sonified data from this GPS system resonates with the motion of the sextant viewfinder on board a boat. Moving underwater, lowering a hydrophone beneath the surface, the complexity of the world of underwater sound opens up, rich with biotic and abiotic sounds. Dolphin echolocation uses sound to bounce off surfaces underwater to help determine location and position. Anthropogenic sounds of engines, anchors and depth finders, from pleasure yachts in a national marine reserve in Spain, drown out biotic and abiotic sounds. All these connect in the mind, where EMDR treatments use sound to help navigate through associations and memories. I summarize the piece as follows:

> *Fishing for Sound* creates a sea of spatial connections between phenomena underwater, in the mind, and from outer-space, weaving sounds from marine environments, psychotherapy and sonified navigation satellites. Common to each of these is a mass of background noise - of environment, memory and information - where listening is like fishing for sounds.

7.9 Instruments in Environment: towards a 'techno-intuition' through sound.

From Hemingway's ill-fated fisherman's tackle to Payne and McVay's use of hydrophones and Dunn's ultrasonic recordings of bark beetles, relationships to environment drawn through sound are often profoundly bound up with technology. In order to hear, collect, transform, study, analyse and intervene through sound, instruments must be specially designed. There is a long history of musicians and scientists making their own instruments and equipment. This hearing through technology raises questions as to how these instruments enable as well as inhibit certain forms of knowledge.

From this perspective a different notion of instrument can be developed. By extending our sensory and cognitive capabilties through instruments one can imagine the emergence of an

'environmental cyborg' that can experience extreme and uninhabitable environments, such as deep sea, through the extensions of technology (Helmreich, 2007). Similarly, by extending our perception beyond the human audible range, we can learn from underwater sounds made by cetaceans and from the terrestrial sounds of other animals, such as bats, which similarly navigate by echolocation. Lucier's *Quasimodo* (1970) (analysed in chapter five) and *Vespers* (1968) can be thought of in these terms, the first inspired by the humpback whale's ability to send sound over very long distances, and the second inspired by bat's ultrasound capabilities.

Examples from my own work move towards my idea of *techno-intuition*, which encourages the combination of different ways of knowing, through both technological artefact and intuitive response. This theory builds on ideas I put forward in 'Inside-Out Instrument', rethinking the traditional relationship between a musician's instrument, body and technology. Since the development of the loudspeaker and electronic sound technology, the sound is commonly detached from the source of body and instrument, in effect becoming dispersed in a space surrounding the musician. The traditionally intimate relationship between body, instrument and sound production, is turned inside-out so that the instrument can in effect be *inhabited* rather than held (Harris, 2006). Conceptually my own instrument design is based on facilitating techno-intuition by absorbing technologies and techniques into an intuitive way of moving through the world. I aim to allow my instruments to become a natural, intuitive extension of myself or other players or participants.

Sailing, ship navigation and submarine cartography offer examples that support a conception of a more immersive, inhabited relationship between the body, instrument and environment. The boat is an extension of the sailor - in effect an instrument - and the art of sailing combines the ability to control this instrument with complex, unpredictable, and ever-changing environmental factors. At the Ear to the Earth Festival in New York (2010) I recited the following text as the introduction to my sound and video work *Sail* (2010).

> Sailing on the surface of the sea, I am propelled by wind and waves. Choosing the fastest angle at about 135 degrees to the wind direction, I am sailing on a 'broad reach', the boat moving almost as fast as its hull speed, racing sideways down the waves. The boat is picked up by the waves and surges with them. The wind hitting the sails propels the boat forward, healing in the gusts. Constant motion, undulating surface, I am keeping aware of the next wave picking up the boat, the next gust pushing on the sails, compensating for the drag on the rudder as it plows through the water. Keeping everything in balance, adjusting instantly to every feel of change in

> wind, waves and resistance, to keep the boat flying forward through the water, across its surface. The sounds - of tension in the drum tight rigging, the hull vibrating, the waves - guide me.

In such a situation, rather than only thinking consciously about what one is doing, one is also actively and intuitively doing it. The two ways of thinking and being in the world seem oppositional, often because technologies are not designed with this in mind. The absorption of technological interfaces into fluid, intuitive group collaboration has been researched by cognitive scientist Edwin Hutchins using the specific example of coastal navigation on a large ship (Hutchins, 1995). Such intuitive collaboration is also described in Helmreich's anthropological analysis of scientists working in a submarine who intuitively navigate through deep ocean terrain largely by sound (Helmreich, 2007). A clear everyday example is the way GPS navigation systems tend to overrule peoples ability to navigate using traditional methods, where reliance on GPS technology that suddenly fails leaves people completely lost. My design of the Satellite Sounders consciously engaged with this phenomenon by turning GPS data into sound in order to provoke a re-experience of navigation and a renewed sense of embodied location in environment. This is written about extensively in the interview on the project where I first outline the notion of techno-intuition (Harris, 2009).

Ironically, our ability to create and adapt to new instruments, technologies and tools has meant that the technology becomes the determining factor that dominates our ways of thinking, behaving and developing. The goal with techno-intuition is to get over a blind faith in technology, and to encourage an attitude to instrument development that maximizes our physical and cognitive abilities. It is not simply a romantic notion of going back to a time before technology (as if this were even possible!) Rather, it leads to an idea of technological development that, by being more attuned to human physiology, is ultimately more sustainable and sensitive to environment.

7.10 Conclusion

This dissertation began with outlining two central questions:

1. How does sound mediate our relationship to environment?
2. How can contemporary multidisciplinary art practice articulate and explore this relationship between sound and environment?

I have attempted to systematically investigate the key facets of these questions through my artistic research process, combining practical and theoretical approaches while reflecting on my own work and that of others. In my own works I have explored various ways of modeling these relationships to environment, for example, by making underwater sounds audible using hydrophones, by mapping data from satellites onto sounds listened to on portable instruments and by creating installations and performances using field recordings. These experiments resulted in insights into how a physical activity, such as walking or swimming, can induce a mental or altered state of awareness and connection. Such a state can be enhanced by sound and listening, producing richer forms of awareness and knowledge of ones relationship to the environment through practical engagement than could be achieved through theoretical analysis alone.

Shifting paradigms in diverse disciplines, from the arts to the sciences, insist that we are literally part of, and inextricable from, the environment we study. This perspective is demonstrated in my discussion of early environmental art from the 1970s and the proliferation of environmental artwork since the 1990s. Scorescapes incorporates a shift away from assuming a passive listener, consuming sound, to a recognition of the influence of our actions and presence on the environment with which we, as listeners, engage. Acknowledging our systemic relationship among complex networks of interacting ecological parts requires an active approach in which we are an immersed participant rather than simply an observer. This realisation, in turn, demands that we see beyond the conventional limitations of the composer as musical specialist and embrace a transdisciplinary approach towards sound and sonic research.

During the research it became clear that it is especially challenging to be actively engaged in an environment that is inaccessible to human physiology, whether due to being extreme in climate, underwater, or beyond human hearing capabilities. As only a portion of environmental sound occurs within the human hearing range, accessing sounds beyond it demands some form of technological mediation and interpretation. The audio-visual installation, *Pink Noise,* and performance, *Fishing for Sound,* exemplify my artistic approach to absorbing the complex topic of underwater sound into a perceptually immersive (rather than didactic) experience, while emphasizing the importance of making the inaudible audible.

My work with environmental sound has made it clear that understanding the contextual nature of sound, in terms of spatial acoustics and interaction with other sonic ecologies, is crucial. This insight builds on Schafer's early soundscape ideas and LaBelle's more recent notion of the 'relational' quality of sound, both of which concur that sounds can only be

understood in relation to the broad environment in which they occur. My analysis of the bioacoustic work of André and Dunn led me to consider to what extent such notions of a relational, contextual and embodied approach to understanding sound in the environment can extend to physically inaccessible environments such as those inhabited by whales and cephalopods underwater or bark beetles inside a tree. Through the artistic process of making *Pink Noise, Fishing for Sound, Tropical Storm* and other works, realising a performance of Lucier's *Quasimodo*, and working with Oliveros' Deep Listening techniques, I recognised the central importance of considering the *context* in which sounds occur rather than exclusively the qualities of a sound itself. Such an attitude presents a significant shift in the role of the composer. From this perspective, the act of composition emphasizes learning to listen in order to understand sounds in relationship to their environment, and enabling other listeners to do the same.

The works and experiences addressed in this final chapter have generated a number of ideas that extend the initial research questions and suggest directions for future artistic research:

1. Considering the parallels between energy, vibration and sound to promote a deeper understanding of reliance on sound technologies using electrical energy.
2. Creating embodied experiences (either directly, or indirectly) through careful combinations of image, sound, instrument, installation, presentation and environment.
3. Finding ways to bringing the sonic unconscious into consciousness in a way that is parallel to making the inaudible audible.
4. Further development of the notion techno-intuition and its application in instrument design and interaction with the environment by combining technological and intuitive ways of knowing.

The Scorescapes research project has mapped given approaches and suggested potential trajectories between sound, technology, environment and sonic consciousness. In general, putting such ideas into practice, either through my own work or the work of others, creates possibilities for heightened awareness and engagement in environment. The environment is continuously being developed and transformed by human intervention. Understanding sounds' role in these transformations can open up greater consciousness of the interrelation of factors that can lead towards more sustainable practices in the arts as well as science and other fields.

Abstract

This dissertation explores sound, its image and its role in relating humans and our technologies to the environment. It investigates two related questions: How does sound mediate our relationship to environment? And how can contemporary multidisciplinary art practices articulate and explore this relation between sound and environment?

Scorescapes is predicated on the idea that artists and scientists are a part of the sonic environments we study. Thus we cannot assume a passive role of listening without recognising the influence of our actions and presence on the environment with which we engage. The systemic relationship among elements in a complex ecology demands an active approach in which we conceive of ourselves as immersed participants rather than simply as objective observers. This realisation, in turn, demands challenging conventional conceptions of the composer as musical specialist and embracing a trans-disciplinary approach towards sound and sonic research.

Given this attitude towards direct engagement in environment, my work as an artist forms a central part of my research method. The Scorescapes project includes audio-visual installations and performances, performative lectures, electronic instruments, sonic walks and collaborations with improvising musicians. In addition, the project has involved close interactions with composers David Dunn, Alvin Lucier and Pauline Oliveros, and bio-acoustic scientist Michel André. Engaging with these experts and creating and presenting new works allows me to apply and test theoretical ideas. This, in turn, encourages new and unexpected questions to arise that can then be explored theoretically. The written dissertation combines analysis of theoretical texts on sound, scores, environmental aesthetics and scientific papers, with reflections on my personal experiences and discoveries in recording, editing, exhibiting and performing my artistic works. The artworks generated during the course of the Scorescapes project are an integral part of the dissertation and are documented in the accompanying DVD.

In order to adequately explore the various facets of this research project, and relate it to developments in my own practical work, I have chosen a subject-oriented approach rather than a chronological or historiographical one. Each chapter has a one-word subject title: Score, Scape, Inaudible, Whale, Field and Flare. In the first two chapters I outline my personal artistic interest in the development of the notion of a score beyond a document for notation, proposing that the score facilitates *relationship.* Building on my work with sonic

navigations, I provide theoretical arguments and historical examples to suggest that the score can also exist in the mind and in space. Examining the question - what is it to 'relate to environment' through sound? – I investigate parallels between Acoustic Ecology and Land Art, ecology and systems aesthetics, and the legacy of walking as an art form embodying relationship to environment.

The central three chapters go into considerably more depth on specific topics that require mediation by technology: making the inaudible audible, underwater sound and attitudes to field recording. The physiological limitations of the human hearing range within larger environmental soundscapes highlight the necessity of making the humanly inaudible audible. As an example, the necessity but difficulty of understanding the sonic qualities of the underwater environment that functions largely through sound, is explored through the scientific and artistic work on cetaceans. This leads on to questions of place in field recordings in general and proposes a possible interactive role in environments through recordings.

The concluding chapter is an attempt to synthesise the array of ideas that developed during this research by taking a more personal turn in an analysis of my own art works. Through the artistic process of making *Pink Noise, Fishing for Sound, Tropical Storm* and other works, realising a performance of Lucier's *Quasimodo*, and working with Oliveros' Deep Listening techniques, I recognised the central importance of considering the *context* in which sounds occur rather than exclusively the qualities of a sound itself. Such an attitude presents a significant shift in the role of the composer. From this perspective, the act of composition emphasizes learning to listen in order to understand sounds in relationship to their environment, and enabling other listeners to do the same.

The Scorescapes research project maps given approaches and suggests potential trajectories between sound, technology, environment and sonic consciousness. In general, putting such ideas into practice, either through my own work or the work of others, creates possibilities for heightened awareness and engagement in environment. The environment is continuously being developed and transformed by human intervention. Understanding sounds' role in these transformations can open up greater awareness of the interrelation of factors that can lead towards more sustainable practices in the arts as well as science and other fields. In conclusion, I propose a notion of 'techno-intuition' and its application in instrument design and interaction with the environment by combining technological and intuitive ways of knowing.

Samenvatting

Dit proefschrift is een verkenning van geluid, zijn verschijningsvorm en de manier waarop geluid mens en technologie verbindt met de omgeving. Het onderzoek geeft een antwoord op twee met elkaar samenhangende vragen: welke mediërende positie neemt geluid in in onze relatie tot de omgeving? Hoe kunnen hedendaagse multidisciplinaire kunstpraktijken deze relatie tussen geluid en omgeving tot uitdrukking brengen en onderzoeken?

Mijn uitgangspunt in *Scorescapes* is het idee dat kunstenaars en wetenschappers wezenlijk deel uitmaken van de geluidsomgeving. Dat betekent dat wij geen passieve rol aan het luisteren mogen toekennen; ons doen en laten (luisteren incluis) heeft direct invloed op de omgeving waarmee wij verbonden zijn. In een complex ecologisch systeem vereist de onderlinge samenhang van elementen dat wij onszelf eerder moeten zien als geëngageerde en participerende deelnemers dan simpelweg als objectieve waarnemers. Dit besef eist op zijn beurt van de componist als muziekspecialist dat zij/hij conventionele opvattingen bevraagt en openstaat voor een transdisciplinaire benadering van geluid en onderzoek naar geluid.

Uitgaande van deze opvatting van verbondenheid met de omgeving, is mijn artistieke werk het belangrijkste element van mijn onderzoeksmethode. Het *Scorescapes*-project bestaat uit audio-visuele installaties en performances, *lecture-performances*, de inzet van elektronische instrumenten, geluidswandelingen, en samenwerkingsprojecten met improviserende musici. Het project is tot stand gekomen in nauwe samenwerking met de componisten David Dunn, AlvinLucier en Pauline Oliveros en de bioakoestische wetenschapper Michel André. Door het intensieve contact met deze deskundigen en door het maken en presenteren van nieuw werk kon ik bepaalde theorieën toepassen en uitproberen. Hieruit kwamen dan weer nieuwe en onverwachte vragen voort die op hun beurt theoretisch onderzocht konden worden. Het proefschrift is een combinatie van analyses van theoretische teksten over geluid, partituren, esthetische ideeën over onze leefomgeving en wetenschappelijke, afgewisseld met reflecties op mijn persoonlijke ervaringen en ontdekkingen in de vorm van opnamen, montages, exposities en performances van mijn artistieke werk. De kunstwerken die ik gemaakt heb gedurende het *Scorescapes*-project zijn een integraal onderdeel van mijn proefschrift en zijn gedocumenteerd op de begeleidende DVD.

Om de verschillende aspecten van dit onderzoeksproject op een adequate manier te onderzoeken en in verband te brengen met ontwikkelingen in mijn eigen kunstpraktijk, heb ik gekozen voor een thematische in plaats van een chronologische of historiografische aanpak.

Ieder hoofdstuk heeft een titel bestaande uit één enkel woord: Score (Partituur), Scape (Omgeving), Inaudible (Onhoorbaar), Whale (Walvis), Field (Veld) en Flare (Gloed).

In de eerste twee hoofdstukken schets ik mijn persoonlijke artistieke belangstelling voor een ontwikkeling van het begrip partituur dat meer is dan slechts een notatiesysteem. Mijn voorstel is om een partituur te beschouwen als een fenomeen dat *relaties*faciliteert.

Mijn werk met sonischenavigaties dient als onderbouwing voor theoretische argumenten en historische voorbeelden die leiden tot mijn idee dat een partituur ook kan bestaan in iemands hoofd of in de ruimte. Aan de hand van de vraag 'Wat betekent het je verhouden tot de omgeving door middel van geluid?' onderzocht ik parallellen tussen *AcousticEcology* en *Land Art*, ecologie en systeemesthetiek, en het wandelen als een vorm van kunst waarbij de relatie tot de omgeving belichaamd wordt.

De belangrijkste hoofdstukken drie, vier en vijf gaan dieper in op specifieke onderwerpen waarbij de mediërende functie van technologie centraal staat: het onhoorbare hoorbaar maken, het ontsluiten van onderwatergeluid, en het maken van *field recordings*. De fysiologische beperkingen van het menselijk gehoor bij het grotere geheel van omgevingsgeluiden maken het hoorbaar maken van het voor mensen onhoorbare, noodzakelijk. Bijvoorbeeld, de noodzaak maar ook de moeilijkheid om grip te krijgen op onderwatergeluiden, wordt onderzocht via wetenschappelijk en artistiek onderzoek naar walvissen. Dit leidt tot vragen aangaande de status van 'plaats' in *field recordings* in het algemeen en mijn voorstel voor een mogelijk interactieve invloed van geluidsopnamen op leefomgevingen.

In het slothoofdstuk geef ik, in een poging om van de overvloed aan ideeën die gedurende dit onderzoek opkwamen een geheel te maken, met een analyse van mijn artistieke werk een iets persoonlijker wending aan het verhaal. Door artistieke processen die leidden tot werken als *Pink Noise, Fishingfor Sound, Tropical Storm* en andere, een performance van Lucier's*Quasimodo* en het werken met Oliveros' *DeepListening* technieken, heb ik het cruciale belang ingezien van de *context* waarin geluiden voorkomen, hetgeen meer is dan louter de eigenschappen van geluid zelf te bestuderen. Dat inzicht betekent een belangrijke omslag in de rol van de componist. Vanuit dit perspectief is componeren vooral het leren luisteren naar geluiden in relatie tot hun omgeving, en luisteraars aanzetten hetzelfde te doen.

Het *Scorescapes*- onderzoeksproject brengt verschillende benaderingswijzen in de mogelijke relaties tussen geluid, technologie, omgeving en geluidsbewustzijn in kaart. Door deze benaderingswijzen in de praktijk te brengen, hetzij in mijn eigen werk of door het werk van anderen, kan er een scherper bewustzijn van en betrokkenheid op de omgeving ontstaan. De omgeving wordt voortdurend ontwikkeld en getransformeerd door menselijke interventies.

Inzicht in de rol die geluid speelt bij deze transformaties leidt mogelijk tot een beter begrip van samenhangende factoren die kunnen uitmonden in duurzamere artistieke, wetenschappelijke en andere praktijken. Tot slot stel ik het begrip 'techno-intuïtie' voor bij het ontwikkelen van instrumenten en de interactie met de omgeving, een combinatie van technologisch en intuïtief weten.

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Appendix 2: Chronology of Work September 2008 - June 2011

A2.1 Artistic Works, Exhibitions And Performances

— *Pink Noise,* WRO Media Art Biennale, Wroclaw, Poland
— *Scorescapes,* solo show: including *Pink Noise, Tropical Storm, Fishing for Sound, S.W.A.M.P. #3, Tuning In/Spacing Out,* Sonic Unconscious, Issue Project Room, Brooklyn New York
— *Fishing for Sound*, Dump Time, Shedhalle, Zurich
— *Taking Soundings* and *Navigating by Circles,* Ground Level, Hayward Gallery Touring, UK
— *Fishing for Sound, Sail, Swim,* Ear to the Earth Festival, Greenwich Music House, EMF, New York
— *Taking Soundings* and *Navigating by Circles,* Ground Level, Hayward Gallery Touring, UK
— *S.W.A.M.P.* #2, Galerie Mario Mazolli, Berlin
— *2x2: Therapy for Future Flooding*, Machine Project, Hammer Museum UCLA, Los Angeles
— *Scorescapes,* Resonator, A/V Festival, Culture Lab, Newcastle, UK
— *Fishing for Sound,* sound performance, Sonic Acts XIII Festival, Paradiso, Amsterdam
— *Pink Noise,* video sound installation, Esemplasticism, Club Transmediale, Berlin
— *Sun Run Sun: Satellite Sounding,* LuisterSalon, Arti et Amicitiae Amsterdam
— *Now Stripe Time*, sound and video performance, DNK/Smart, Amsterdam
— *S.W.A.M.P. #1,* sound concert, Diapason Gallery Brooklyn, New York
— *Tropical Storm*, video and sound installation, Atlantic Center for the Arts, Florida
— *Bell Buoy*, video and sound installation, Atlantic Center for the Arts, Florida
— *Sun Run Sun: Satellite Sounders,* Playing the City, Schirn Kunsthalle, Frankfurt
— *Sun Run Sun: Sun Running,* Art and Electronic Media, Netherlands Media Art Institute, (NIMK) Amsterdam
— *Underwater sounds with Contrabass Flute*, Karnatic Lab, Amsterdam
— *Sun Run Sun: Satellite Sounding*, WEALR09 New Music Festival, California State University, Los Angeles
— *Hydro,* sound performance, Karnatic Lab, Amsterdam
— *Sun Run Sun,* sound performance, Netherlands Royal Society of Musicology, Utrecht
— *Sun Run Sun: Satellite Sounding,* Luister Salon, Korzo Den Haag
— *Sun Run Sun: Sun Running,* performance, Re:Visie, Netherlands Film Festival, Utrecht
— *Sun Run Sun: Satellite Sounders,* sound GPS instruments, PICNIC08, Virtueel Platform, Amsterdam
— *Taking Soundings Scores,* graphic scores, MACBA, Museum of Contemporary Art, Barcelona

A2.2 Lectures

— *Tuning In and Spacing Out*, Issue Project Room, Brooklyn New York
— *Scorescapes* research presentation, ORCiM General Assembly, Orpheus Institute for Advanced Research in Music, Ghent
— *Scorescapes*, Artist Talk, STEIM, Amsterdam
— *Scorescapes*, Lecture in Sound and Score International Seminar, Orpheus Institute for Advanced Research in Music, Ghent
— *Tuning In and Spacing Out*, College of Fine Arts, University of New Mexico, Albuquerque, US
— *Tuning In and Spacing Out*, Sam Fox School of Design, Washington University St Louis, US
— *Making the Inaudible Audible*, International Symposium of Electronic Arts (ISEA2010 Ruhr), Dortmund
— *Sound Flares and Scorescapes*, Certain Sundays Sound Salon, Sowieso Neukoelln, Berlin
— Artist Talk, Resonator, A/V Festival, Culture Lab, Newcastle, UK

— *Tuning In and Spacing Out*, Collaborative lecture with Edward Shanken, Sonic Acts XIII Festival, Paradiso, Amsterdam
— Guest Lecture, ArtScience InterFaculty Colloqium, Royal Academy of Art, The Hague
— *Now Stripe Time and Moby Dick,* lecture at season opening of DNK / Smart Project Space concert series, Amsterdam
— *Scorescapes,* Laboratory for Applied Bio-Acoustics, Polytechnic University of Catalunya, Barcelona
— Presentation for Alvin Lucier and Associate Artists, Atlantic Center for the Arts, Florida
— *Scorescapes,* research presentation, Orpheus Institute for Advanced Research in Music, Ghent
— *Scorescapes: between the Map and the Music*, Netherlands Royal Society of Musicology, Utrecht

A2.3 Residencies, Research Visits, Collaborations

— Deep Listening Retreat with Pauline Oliveros, Nau Coclea, Spain, July 2010
— Resonator Workshop/Residency, A/V Festival, Culture Lab, University of Newcastle, March 2010
— Associate Artist Residency with Alvin Lucier, with financial support from Advance an Artist, Atlantic Center for the Arts, Florida, 3 weeks in May/June 2009
— Research visit to initiate and define a collaboration with scientist Professor Michel André, including writing 1200 word proposal, Laboratory for Applied Bio-Acoustics, Polytechnic University of Catalunya, Barcelona, July 2009
— Artist Residency, studio work on sound spectrogram images of field recordings, STEIM Amsterdam, during July 2009
— Research visit to meet musicologist Douglas Kahn and scientist James Crutchfield (collaborator with David Dunn), University of California, Davis, June 2009

A2.4 Publications

Peer Reviewed Publications:
— 'Scorescapes: The Score as a Bridge between Sound, Self and Environment', in *Sound and Score* Orpheus Institute and Leuven University Press, forthcoming 2011
— 'Fishing for Sound: Towards an Embodied Understanding of the Underwater Sonic Context of the Whale', under consideration by *Interference Journal* 2, 2011
— 'Making the Inaudible Audible: Strategies and Disagreements', *Proceedings of the International Symposium of Electronic Arts*, ISEA 2010 Ruhr, Dortmund. August 2010
— 'Field: Thoughts on the Extremities of Field Recordings', *Proceedings of Sounding Out Conference*, Bournemouth. September 2010
— 'Taking Soundings: A Composer's Investigations into Technologies of Navigation', *Proceedings of Mutamorphosis: Challenging Arts and Sciences*, Prague. November 2007, publication 2009

Interviews:
— 'Dolphins, Spectrograms and Scorescapes: an interview with Yolande Harris' by Morgan Currie, *Masters of Media Blog*, University of Amsterdam, 2009
— 'Aiming for Dead Reckoning: A conversation between Yolande Harris and Annet Dekker', in Brickwood, Cathy and Annet Dekker (eds.), *Navigating E-Culture*. Amsterdam: Virtueel Platform, 2009, with video documentation of Sun Run Sun on DVD
— 'A Journey Through Sound: an interview with Yolande Harris' by Carmen Hutting and Annet Dekker, *TagMag 5*, <>TAG publication. Den Haag, 2008

Catalogues / Reviews / Published Writings by others (selection):
— 'Beating the Bounds' by Kit Hammonds, *Ground Level Exhibition Catalogue*, discusses *Taking Soundings and Navigating by Circles (Sextant),* Hayward Gallery /Southbank Centre, 2010
— 'On Location: The Poetics of Space: Sonic Acts XIII' by Rahma Khazam, "*Fishing for Sound* brilliantly exploited sounds capacity to conjure up a sense of place", in *The Wire: Adventures in Modern Music*, number 315, May 2010
— 'Knowing Art / Transcending Science: Perception, Consciousness, Synchronicity and Transgnosis' by Edward A. Shanken, *Esemplasticism : The Truth is A Compromise, Exhibition Catalogue*, discusses installation Pink Noise, TAG/ClubTransmediale, Berlin, January / February 2010
— 'Tolerance Rather than Hospitality: Free to Move, Left to Do Your Own Thing, Yolande Harris' by Danielle Van Zuilen, article based on an interview, *Dutch Mountains no.1* SICA Dutch Centre for International Cultural Activities, Amsterdam, January 2010
— 'Sun Run Sun: Satellite Sounders' in Matthias Ulrich ed. *Playing the City Exhibition Catalogue* with video documentation on DVD, Schirn Kunsthalle Frankfurt. September 2009
— *Art and Electronic Media,* Edward A. Shanken (Phaidon 2009) mention of *A Collection of Circles* (2005) and *Sun Run Sun* (2008) in Survey chapter
— 'Acoustic Ecology and the Experimental Music Tradition' by David Dunn, *New Music Box*, January 9, 2008 mentioned as one of 20 practitioners in the field
— 'Possibility of Action: The Life of the Score', *Taking Soundings* in exhibition catalogue 16 June – 5 October 2008, Study and Documentation Centre, MACBA (Museum of Contemporary Art, Barcelona)
— '*Sun Run Sun* and *Taking Soundings*' in Atau Tanaka et al. eds. *Creative Interactions – The Mobile Music Workshop 2004 – 2008*, University for Applied Arts, Vienna 2008

A2.5 Workshops

— *Scorescapes* workshop director for Masters students, Multimedia and Performance Group, Academy of Media Arts (KHM), Cologne, November 2008

A2.6 Scorescapes Website

— 'Scorescapes: Scores, Environment and Sonic Consciousness', set up site for ongoing online documentation of artistic research process http://www.scorescapes.net

A2.7 Conferences

Participation:
— "Sound and Score" International Seminar, Orpheus Institute for Advanced Research in Music, Ghent 15-16 December 2010. Paper presentation *Scorescapes: The Score as a Bridge between Sound, Self and Environment.*
— ISEA2010 Ruhr International Symposium for Electronic Arts, Dortmund 20-28 August 2010. Paper presentation *Making the Inaudible Audible: Strategies and Disagreements.*
— "Heden, Verleden en Toekomst van de Nederlands Muziekwetenschap," Netherlands Royal Society of Musicology, Utrecht 31 January – 1 February 2009. Conference presentation and solo performance. Paper presentation *Scorescapes: between the Map and the Music* and sound performance *Sun Run Sun.*
— STEIM Micro Jamboree, Amsterdam 8 – 11 December 2008. Official blog writer on Energy Music and other sessions.
— "Walled Garden: Communities and Networks post Web2.0", Amsterdam 20 – 21 November 2008. Workshop participant: Flwr Pwr, on emergent behaviors in networked environments.

Attendance:
— "Experimentation in the Context of Performance Practice", 3rd International ORCiM Seminar, Orpheus Institute for Advanced Research in Music, Ghent, 27-28 April 2011
— "Alternative Now" WRO Media Art Biennale, Wroclaw, Poland, 9-14 May 2011
— "en RESONÀNCIA —Encontre Internacional Noves Fronteres de La Ciencia, L'Art I El Pensament" (New Frontiers in Science, Art and Thought) La Pedrera, Barcelona 30 September – 1 October 2008, with David Dunn and Michel André presenting.
— Sound + Science Symposium UCLA Art | Sci Center + Lab**,** University of California Los Angeles, 5 - 6 March 2009 (online live video-stream).
— "Utopian Practices: Science, Art & Design Re-united", organised by Waag Society, the Royal Netherlands Academy of Arts and Sciences' Virtual Knowledge Studio and The Arts & Genomics Centre of Leiden University, De Balie Amsterdam 19 March 2009

Appendix 3: Biographies of Key Individuals

Michel André (1963-) Marine biologist specializing in bioacoustics. He is Professor at the Technical University of Catalonia (UPC) and Director of the Laboratory of Applied Bioacoustics (LAB). His research involves the development of acoustic technologies for the control of noise pollution in the marine environment; the study of the biological and pathological impact of noise pollution on cetacean acoustic pathways; the mathematical, physical, morpho- and electro-physiological mechanisms of the cetacean bio-sonar as well as the extraction of the information from their acoustic signals.

Louis Andriessen (1937-) Dutch composer and pianist. One of Europe's most eminent and influential composers, Andriessen's compositions have attracted many leading exponents of contemporary music, including the Asko|Schoenberg, and two ensembles named after his works De Volharding and Hoketus. His work has been commissioned and/or performed by the San Francisco Symphony, BBC Symphony Orchestra, Kronos Quartet, London Sinfonietta, Ensemble Modern, Ensemble InterContemporain, Icebreaker, the Bang on a Can All Stars, and the California EAR Unit. He teaches composition at the Royal Conservatory at The Hague.

Gregory Bateson (1904 - 1980) English anthropologist, linguist, and cyberneticist whose work intersected that of many other fields. In the 1940s he helped extend systems theory/cybernetics to the social/behavioural sciences. He spent the last decade of his life developing a "meta-science" of epistemology to bring together the various early forms of systems theory growing within a number of scientific fields. Books include *Steps to an Ecology of Mind* (1972) and *Mind and Nature* (1979). *Angels Fear* (published posthumously in 1987) was co-authored by his daughter Mary Catherine Bateson.

John Berger (1926-) English art critic, novelist, painter and author. His novel *G.* won the 1972 Booker Prize, and his essay on art criticism *Ways of Seeing*, written as an accompaniment to the BBC series of the same name, remains one of the most popular art books and continues to be used as a college text. Other titles include *About Looking* (1992) and *Another Way of Telling* (1995).

Jack Burnham (1931-) American art critic and historian. Taught art history at Northwestern University and the University of Maryland. Primary theorist and proponent of systems art, and art and technology in the 1960s. Burnham was also a leading supporter of conceptual art and propounded a structuralist art historical method. Books include *Beyond Modern Sculpture* (1968), *The Structure of Art* (1970) and *Great Western Salt Works* (1974). Burnham also curated the infamous *Software* exhibition in New York, 1970.

Cornelius Cardew (1936 -1981) English experimental composer and founder (with Howard Skempton and Michael Parsons) of the Scratch Orchestra, an experimental performing ensemble. His graphical score *Treatise* consists of 193 pages of lines and symbols without instructions for interpretation. His collected writings appear in *Cornelius Cardew* (2006). Recordings include *The Great Learning* (1971, 2002) and *Treatise* (QuaX Ensemble, 2009). Biographical treatments include John Tilbury, *Cornelius Cardew* (2008) and Andrea Phillips, Adrian Rifkin, Rob Stone, *I Play for Today* (2009).

James P. Crutchfield (1955-) Professor of Physics at the University of California, Davis, where he is Director of the Complexity Sciences Center. Formerly Research Professor at the Santa Fe Institute, where he ran the Dynamics of Learning Group and the Network Dynamics Program. Current research centres on computational mechanics, the physics of

complexity, statistical inference for nonlinear processes, genetic algorithms, evolutionary theory, machine learning, quantum dynamics, and distributed intelligence.

David Dunn (1953-) American composer who primarily engages in site-specific interactions or research-oriented activities. Much of his current work is focused upon the development of listening strategies and technologies for environmental sound monitoring in both aesthetic and scientific contexts. Dunn is internationally known for his articulation of frameworks that combine the arts and sciences towards practical environmental activism and problem solving. From 1970 to 1974, he was assistant to the American composer Harry Partch. His compositions and soundscape recordings have appeared in over 500 international forums, concerts, broadcasts, and exhibitions.

Helen and Newton Harrison (1929-) (1932-) Considered amongst the leading pioneers of the eco-art movement. The Harrisons have worked for almost forty years with biologists, ecologists, architects, urban planners and other artists to initiate collaborative dialogues to uncover ideas and solutions, which support biodiversity and community development. Their work involves extensive mapping and documentation of these proposals in an art context. Past projects have focused on watershed restoration, urban renewal, agriculture and forestry issues among others. The Harrisons' visionary projects have often led to changes in governmental policy and have expanded dialogue around previously unexplored issues leading to practical implementations throughout the United States and Europe.

Douglas Kahn (1951-) American scholar with research concentrations in auditory culture, the history and theory of sound in the arts, and new media arts. Professor of Media and Innovation at the National Institute of Experimental Arts (NIEA), at the University of New South Wales, Australia. He was the Founding Director of Technocultural Studies and is Professor Emeritus in Science and Technology Studies at the University of California, Davis. Books include *Noise, Water, Meat: A History of Sound in the Arts* (MIT Press, 1999), co-editor of *Wireless Imagination: Sound, Radio and the Avant-garde* (MIT Press, 1992), and editor of an ongoing book series, "*Auditory Culture*", from MIT Press.

Brandon LaBelle (1966-) American artist and writer based in Berlin. His work explores the meeting of the public and the private, sociality and the narratives of everyday life, using sited constructions, sound and performance as creative supplements to existing conditions. Professor of new media at the National Academy of the Arts in Bergen, Norway. Recordings include *Dirty Ear* (2008) and *Death of the Composer* (2001). Radio works include *Table Talk* (2009) and *Radio Flirt* (2008). Books include *Acoustic Territories: Sound Culture and Everyday Life* (2010), *Radio Memory* (2008) and *Background Noise: Perspectives on Sound Art* (2006).

John Lilly (1915 - 2001) American physician, neuroscientist, psychoanalyst, philosopher and writer. His pioneering research on dolphin intelligence and communication appears in *Man and Dolphin: Adventures of a New Scientific Frontier* (1961). Lilly's work helped the creation of the United States Marine Mammal Protection Act. He is also credited with the creation of the isolation tank. His research using sensory deprivation, often in combination with psychedelic drugs, was documented in his best-selling book *Center of the Cyclone* (1972), which was loosely interpreted in the Hollywood cult-film *Altered States* (1980).

Lucy Lippard (1937-) American writer, activist and curator, Lippard was among the first writers to recognize the de-materialization at work in conceptual art and was an early champion of feminist art. She is the author of 21 books on contemporary art, including *Six Years: The Dematerialization of the Art Object* (1973) and *Overlay* (1983). Awards include Guggenheim Fellowship (1968), College Art Association (1975), and National Endowment

for the Arts. She was awarded an honorary doctorate from Nova Scotia College of Art and Design in 2007.

Annea Lockwood (1939-) New Zealand born American composer. She taught electronic music at Vassar College, where she is Professor Emeritus. An early pioneer of soundscapes, her work often involves recordings of natural, found sounds, as in her well-known *A Sound Map of the Hudson River* (1982, Lovely Music, 1989).

Alvin Lucier (1931-) American composer of experimental music and sound installations that explore acoustic phenomena and auditory perception. Professor Emeritus, Wesleyan University, Lucier was a member of the influential Sonic Arts Union, which included Robert Ashley, David Behrman, and Gordon Mumma. Much of his work is influenced by science and explores the physical properties of sound itself: resonance of spaces, phase interference between closely-tuned pitches, and the transmission of sound through physical media.

Pauline Oliveros (1932-) American accordionist and composer who is a central figure in the development of post-war electronic art music. She was a founding member of the San Francisco Tape Music Center in the 1960s, and served as its director. She has taught music at Mills College, the University of California, San Diego (UCSD), and Rensselaer Polytechnic Institute. Oliveros has written books, formulated new music theories and investigated new ways to focus attention on music including her concept of Deep Listening.

Andrea Polli (1968-) Digital media artist living in New Mexico. Her work with science, technology and media has been presented widely in over 100 presentations, exhibitions and performances internationally. Polli is currently Mesa Del Sol Endowed Chair of Digital Media and Associate Professor in Fine Arts and Engineering at The University of New Mexico.

R. Murray Schafer (1933-) Canadian composer, writer, music educator and environmentalist; perhaps best known as founder of *World Soundscape Project*, which launched the acoustic ecology movement. His book *The Tuning of the World* (1977) republished as *The Soundscape* (1994), defined many aspects of the field. Awards include Glenn Gould Prize (1987), Canada Council for the Arts (2005), and Governor General's Performing Award for Lifetime Artistic Achievement (2009).

David Toop (1949-) English musician and author. Visiting Research Fellow in the Media School at London College of Communication since 2001. Toop published his pioneering book on hip hop, *Rap Attack,* in 1984, *Ocean of Sound* (1995) and *Haunted Weather* (2004). Since the 1970s, Toop has also been a significant presence on the British experimental and improvised music scene, collaborating with Max Eastley, Brian Eno, Scanner, and others.

Hildegard Westerkamp (1946 -) German and Canadian composer of electroacoustic music. Many of her compositions deal with the acoustic environment. Particular themes include soundscapes of urban or rural areas, including voices, noise, silence, music and media, as in her renowned *Kits Beach Soundwalk* (1990). She is a founding member of the World Forum on Acoustic Ecology (WFAE) and a co-founder of Vancouver Co-op radio. She taught at Simon Fraser University in the 1980s and was the subject of the doctoral dissertation *Sounding Places with Hildegard Westerkamp* (1999).

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Since the beginning of my doctoral trajectory in September 2008 I have been fortunate to have the support of many colleagues, friends and family. The early foundations of the research presented here, began as early as 2003, first as artistic researcher at the Jan van Eyck Academy in Maastricht, then as visiting fellow at the Academy of Media Arts (KHM) in Cologne, followed by artist in residence at the Netherlands Media Art Institute (NIMk) in collaboration with STEIM in Amsterdam. I am grateful to these institutions and the various individuals who stood behind my work and actively encouraged its development.

My decision to continue with academic research in the form of a PhD, and the belief that this constitutes a fundamental approach to my artistic practice, was recognised and encouraged by Professor Frans de Ruiter, who made my dream of pursuing a PhD on my own terms as a practicing artist seem feasible and desirable. This opportunity to explore in more depth the relationship between my practice and its inextricable links with research and theory has, as I had hoped, contributed rigour and focus to my work while opening up vistas for potential directions in the future. I am also grateful to Frans for trusting and honouring my request for two supervisors, musicologist Dr. Bob Gilmore and composer David Dunn, experts and mavericks in this rapidly developing field, whose guidance kept me on my own constantly evolving track.

My interest in cetaceans and underwater sound began as a hunch that developed out of my earlier work on sonic navigations, in particular the echolocation of dolphins and bats. Rosita Wouda, acting coordinator of the DocArtes program at the time, trusted this hunch and encouraged it unceasingly, giving me my first book on whale song and (perhaps more importantly) establishing a crucial contact with marine bio-acoustician Professor Michel André. I am very grateful to Rosita for her continued support through the challenges of the first two years of research.

Michel André has been consistently generous with his time and open to my ideas and participation in his own research on underwater sound, cetaceans and the mitigation of noise pollution in the world's oceans. His openness to the largely foreign workings and methods of an independent artist is unusual but nothing less than visionary in recognising and actively supporting collaborations between artists and sciencists. I am grateful to Michel for opening this world up to me.

Of the many others who have influenced my research and supported my projects I would like to thank composers Alvin Lucier, Pauline Oliveros, Annea Lockwood; the remarkably inventive and sensitive musicians collaborating in *S.W.A.M.P.* (Ned McGowan, Christopher Williams, Kato Hideki, Stephen Menotti, Morton Olsen, Werner Dafedecker, William Lang

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I would also like to express my gratitude for the institutional support from sponsors and curators and from the venues and festivals where I have presented my work (see appendix). In particular, I would like to thank the FondsBKVB (Netherlands Foundation for Art, Design and Architecture), Sonic Acts Amsterdam and the Atlantic Center for the Arts Florida, and the curators Anette Schafer and Miles Chalcraft, Annet Dekker, Hicham Khalidi, Kit Hammonds and Matthias Ulrich.

I especially wish to thank my parents, architects Anthony and Kathryn Harris, for their unerring support, emotionally, idealogically and intellectually. I do follow in the steps of their idealism and belief in pursuing ones dreams. One of their dreams was their wandering home, yacht *Symphony*, which enabled me to make many of the recordings, inspired my ideas and are fundamental to the final works *Taking Soundings, Navigating by Circles, Sail* and *Pink Noise*.

The beginning of my doctoral trajectory coincided with meeting scholar Edward Shanken. Together we have transformed our worlds and expanded our research endeavours in an idealistic spirit of the sharing and expansion of knowledge through the experience, production and dissemination of art in the context of life. Our collaboration on the lecture-performance *Tuning In, Spacing Out* was an example and experiment into where such ideas can lead.

In unexpected directions! Edward and I married and brought our beautiful daughter Jasmin into the world on the 19th of September 2011. Jasmin 'allowed' me to listen to the sounds of her growing in my womb, to watch images of her via ultrasonic equipment, and experience a relationship between body and mind, perception and understanding, audible and inaudible, on a level I could never have imagined. These experiences are pre-empted in my dissertation. Naturally, I dedicate this thesis to her new life.

Yolande Harris is a composer and artist engaged with sound and image in environment and architectural space. Her most recent artistic research projects *Sun Run Sun: On Sonic Navigations* (2008-2009), and *Scorescapes* (2009-2011) explore sound, its image and its role in relating humans and their technologies to the environment. These works consider techniques of navigation, sound worlds outside the human hearing range, underwater bioacoustics and the sonification of data. They take the form of audio-visual installations and performances, instruments, walks, performative lectures and writings.

Her work is presented internationally in the context of visual art exhibitions, music venues and media art festivals. These include: MACBA Barcelona, Schirn Kunsthalle Frankfurt, Hayward Gallery Touring UK, Netherlands Media Art Institute Amsterdam, V2_ Rotterdam, ISEA Singapore and Ruhr, UCLA Hammer Museum, Villa Croce Genova, Issue Project Room New York, Shedhalle Zurich, Transmediale Berlin, Atlantic Center for the Arts Florida, STEIM Amsterdam, Ear to the Earth Festival New York, WRO Media Art Biennale Poland and Sonic Acts Festival Amsterdam.

Harris is currently an ORCiM Research Fellow at the Orpheus Institute for Advanced Studies and Research in Music in Ghent. Between 2008 and 2011 she was awarded a national artist subsidy from the Netherlands Foundation for Visual Arts, Design and Architecture. From 2007 to 2008 Harris was Artist in Residence at the Netherlands Institute for Media
Art (NIMK, formerly Montevideo) in collaboration with STEIM (Studio for Electro-Instrumental Music) in Amsterdam. During 2006 she was Artistic Fellow in the Sound Department of the Academy of Media Arts (KHM) in Cologne. From 2003 to 2005 Harris was an Artistic Researcher at the Jan van Eyck Academy: Post-Academic Institute for Research and Production in Fine Art, Design and Theory in Maastricht.

Yolande Harris started her Ph.D. in 2008, recently completing her dissertation on artistic research into sound and the environment in the DocArtes program and plans to defend it at the University of Leiden (2011). She holds an M.Phil. in architecture/moving image from the University of Cambridge (2000), a B.A. in Music from Dartington College of Arts (1997), and studied music and art history at Edinburgh University (1995). In addition she has studied musical composition with leading figures in experimental music, Frank Denyer, Louis Andriessen, Lou Harrison, Peter Sculthorpe, Alvin Lucier, Pauline Oliveros and David Dunn.

Teaching features prominently in Harris' work. In 2012 she will be a Lecturer at the University of Leiden teaching a course on soundscapes. From 2006 to 2007 she was Lecturer in Interaction Design at the Technical University of Eindhoven. She has held numerous Visiting Lecturer positions at art and design colleges, including the Academy of Media Arts (KHM) in Cologne, the Royal Academy of Art in The Hague, the Department of Architecture, Design and Building at the University of Technology in Sydney, and the Gerrit Rietveld Academy of Fine Art in Amsterdam.

Scorescapes: Stellingen / Propositions

1. When considering environmental sound, we cannot assume a passive role of listening without recognizing the influence of our actions and presence on the environment with which we engage.

2. Making the otherwise inaudible audible through audification, sonification and visualization techniques, requires *imagination* to think of the presence of sounds one cannot hear, and skills of *interpretation* in making sense of the sonic environments revealed to our hearing range through these processes.

3. The vast role of sound in underwater life must be recognized as a crucial area of research and development, in which collaboration across disciplines must play a central role, in a move towards a sustainable environmental future.

4. The combination of technological and intuitive ways of knowing – a 'techno-intuition' –can guide the development of more subtle interactions with the environment through sound.

5. The act of composition emphasizes learning to listen in order to understand sounds in relationship to their environment, and enabling other listeners to do the same.

6. The study of sound and the practice of active listening provokes a shift in perspective away from the usual visually dominant mode.

7. Actively acknowledging the systemic relationship among elements in a complex ecology demands that we conceive of ourselves as immersed participants rather than simply as objective observers.

8. Conventional conceptions of the composer as musical specialist need to be challenged in order to embrace a trans-disciplinary approach towards sound and sonic research.

9. Consider the technological feat and corresponding emotional intensity of seeing an ultrasound image of a baby in the womb, to be merely a complement to, rather than a replacement of, the complex sensory 'images' created by the bodily experience.

10. "You should work at it until deep experience arises": the Fourteenth Dalai Lama on meditation