Environmental Sound Artists

In Their Own Words

Frederick Bianchi
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Foreword

Although a variety of found sounds have been used in music and musical instruments since the beginning of the twentieth century, it was really in the early 1970s that relating sound to our environment came into play.

In the early 1970s at Simon Fraser University in Vancouver, R. Murray Schafer had begun to express his interests in our sonic environment in a course in noise pollution. To quote his book, titled *The Tuning of the World*, he wrote: "The soundscape of the world is changing. Modern man is beginning to inhabit a world with an acoustic environment radically different from any he has hitherto known...." Schafer's focus on our sonic environment led to Acoustic Ecology, a new field of study that launched the World Soundscape Project. The first actual publication, created in 1973 in the spirit of a study of the local sound environment, was called The Vancouver Soundscape. And from that project emerged the term 'soundscape' which became known as a musical genre.

Hildegard Westerkamp and Barry Truax, working with Schafer, used sounds recorded from the environment as the material of their musical compositions. At that time, the concept of a soundscape linked a sound to its source. A soundscape, by definition, was an audio representation of a real place. Whatever the processing or editing of a recorded sound, to qualify as a soundscape it had to embody the identity of the place that it represented.

As we now look back, however, the connection between sound and place seems to have expanded to the extent that everything became a soundscape. Bernie Krause, for example, documented the world in sound. David Monacchi made points about destruction of habitat and disappearance of species. In short, the concept of a soundscape as a representation of a particular place opened up into a myriad field of different ways of thinking about sound and the environment.

Mark Moffett, ecologist, wrote: "Modern ecologists may have reached a limit on how effectively they can convey messages to the public, and they may now need to draw upon the emotional vibrancy offered by the arts."

The recognition of environmental art, in all of its forms, as an essential aspect of our lives has inspired artists to create a large body of works, all of which, in a wide variety of ways, connect us to the world. The artists whose work is displayed or described in *Environmental Sound Artists* represent a variety of approaches and a wide range of ideas. They are all important.

Joel Chadabe
Ear to the Earth

Preface

Artists have always been drawn to the principles of design and structure inherent in nature. Perhaps it is the orderliness and stability of environmental forces that entice artists to explore the natural architecture of symmetry and balance. On the other hand, it could be the chaos and randomness at work in the environment that has prompted others to expose the mathematical beauty of reiterated forms, the power of repetition, and the forces of physical energy. It is also imaginable that today, a balanced and sustainable environment simply provides a sense of sanity to the tumbling and disorder of life around us. Consequently, it is no surprise that for many artists the lure of the environment is the inevitable destination on a journey seeking artistic purpose and meaning.

While these observations characterize many of the artists presented in this book, we must be careful when generalizing about environmental sound art. It is ultimately an art form that is inherently diverse, constantly expanding, and conceptually elusive. But, one may ask, who are these environmental sound artists, and is there some common link between them? It is true that many environmental sound artists have abandoned the remaining vestiges of Western musical tradition and from these ruins have cultivated a new sensibility grounded in environmental awareness, responsibility, and action. But that may be too limiting a description and an attempt to force a similarity that is either weak or tenuous. At first glance there is no off-the-shelf classification or clear categorization of the environmental sound artists presented in this book. Their personal backgrounds, fields of expertise, and artistic perspectives are unique and often in contrast with each other. Environmental sound artist Andrea Polli, for example, is a Professor of Art and Ecology, China Blue is a trained sculptor, while Bernie Krause has origins as a professional studio musician in the rock world of the 1960s. John Luther Adams is a Pulitzer Prize–winning composer, Craig Colorusso is a former punk rock musician, and John Bullitt transitioned to environmental sound art from a career in geophysics. Gordon Hempton identifies

himself as an acoustic ecologist, Bruce Odland as a sonic thinker, and Zimoun works somewhere within the realm of architecture, engineering, and sculpting.

So it is that one of the key thematic threads that begins to emerge and seeks to unify these artists is, in fact, the contrasts between them. More precisely, it may be the artists' variety and diversity of ideas, philosophies, aesthetics, and beliefs that ultimately speaks the loudest in behalf of environmental sound art. As a result, there is no need to homogenize the colorful, diverse, and assorted essays contained in this book. That is its strength. Through the artists' own words, we begin to understand and experience an art form that is built on variety, resilience, change, and adaptability. These are admirable characteristics.

While we have pointed out the diversity that exists between the individual artists in this book, we must also acknowledge and point out that their creative works do share many thematic similarities. This can be seen primarily through the artists' strategy of appropriation of structure, processes, materials, and impulses derived from the environment around us. This would include the ecological environment as well as urban and built environments. However, like the diversity that exists between the artists themselves, the common themes that connect their works are also subject to contrast and diversity. The individual artworks discussed in this book are characterized by unbounded variation and contrast. Environmental sound artist Joseph Bertolozzi, for example, has created art derived from the sounds produced from percussively playing the surfaces of the Eiffel Tower. Environmental sound artist Andrea Polli's work, *Heat and the Heartbeat of the City,* is a musical sonification of scientific data that models temperature change in Central Park over the next 100 years. The works of Bertolozzi and Polli represent unique and significant processes that exemplify the multidimensionality and diversity inherent in environmental sound art. It is an art form capable of engaging both artist and observer on various perceptual and cognitive levels.

The diversity in creative approaches is apparent throughout the book. Using sonification techniques, like Polli, John Bullitt records the vibrations associated with the Earth's seismic activity, translates them into audible sound, and then creates multi-channel sound installations that allow observers to listen to the planet. According to Bullitt: "Who knows what subliminal effects it may have had on life on Earth? I believe that the time has come to lift these sounds into our collective conscious awareness." Craig Colorusso's *Sun Boxes* installation has much in common with Bullitt's work. Specifically, both artists rely on natural and sustainable processes to generate the sonic result. Colorusso's *Sun Boxes* produce sound based on solar energy. The fluctuation of available solar energy results in a myriad of different, unique, and variable sonic outcomes. Colorusso elaborates on his relationship to the process: "people often ask why I don't do more to manipulate the outcome of the piece. My answer is simple; I'm just trying to get out of the way." Like the seismic vibrations utilized by Bullitt, Colorusso has tapped into a beautifully succinct environmental process that is varied beyond imagination. According to Colorusso, *Sun Boxes* is a system that "improvises with Mother Nature." Furthermore, "there have been

so many amazing moments that I could have never predicted. If I tried to alter the outcome, I might miss something beautiful."

Though Bullitt and Colorusso have created completely distinct works, both technically and aesthetically, they are unified by the appropriation of basic environmental processes that are comprehensible, simple, and beautiful. It is the use of process that unites the two artists. As observers of environmental sound art, we can be moved not only by the sonic output that results from the process but by an appreciation of the process itself. In environmental sound art, process and meaning exist in a blurred dichotomy that can engage the mind and tease the senses on a sliding continuum of aesthetic experience. In some cases the mere description of the work's process or structure can be pleasing even without experiencing the work sonically. Simply stated, some environmental sound artworks are based on fantastically elegant ideas. This is similar to appreciating the beauty of an architectural drawing without the need to see the realization of the finished structure. The concept and design principles alone can be aesthetically and intellectually fulfilling.

Another unifying thematic thread between the works presented in this book is the strong connection to specific spaces, settings, and geographic locations. In this sense, location becomes a primary contextual element and is often integral to the realization of environmental sound art. The environmental sound artist has redefined the notion of performance space and, in doing so, expanded the potential for how we experience and interpret the work. The location context helps contribute to the meaning of the work. The works are as tightly coupled to their physical spatial environments as a Beethoven symphony is coupled to the concert hall. It is the space that brings the context to the work. Through the works of the artists presented in this book, we discover the importance of the unifying theme of space and location and begin to appreciate the great divergence in how the individual artists work with these thematic elements.

In *Meltwater*, for example, Cheryl Leonard records melting ice from a glacier in Antarctica. Leonard states: "One of the allures of making music out of natural materials and environmental field recordings is delving into the minutia of the very quiet." While depicting a world that is imperceptibly changing, Leonard is moved foremost by what is sonically engaging while being inspired by environmental issues such as climate change. This approach is in contrast to Chris DeLaurenti's *Activist Sound,* in which he captures field recordings of protests, testimonies, and other pertinent sonic materials of social change. In both cases, however, Leonard and DeLaurenti are engaged in capturing contextually defining detail, and this experience shapes both of their perspectives as artists. DeLaurenti believes that "The chief challenge of the field is how you respond to what you hear. The field is where you can foster a different way of listening and being in the world."

Philip Blackburn's use of location has similarities with that of Leonard. In *Sewer Pipe Organ*, Blackburn creates a collage of sounds that are played through audio speakers lowered into portions of the sewer system of St. Paul, Minnesota. "The sound characteristics and their intervention into urban life, their site-specificity, are inseparable from their unique location," states Blackburn. The result, similar to Leonard's, is to make visible

and perceptible what is otherwise invisible and unheard. In Blackburn's case, it is the intricacies and complexities of the underground sewer system revealed to the aboveground observer through acoustic characteristics that emerge from an invisible underground labyrinth. Blackburn believes that "Hearing is a particularly good way to bring attention to these spaces because the ears have a better way of processing a sense of volume, material, and space than eyes do in the dark." In both cases, Leonard and Blackburn bring forward a sonic world replete with both contextual and aesthetic information. The listener gains an awareness and altered perspective on what otherwise would have remained invisible and unknown.

Gordon Hempton's environmental sound art is based on site-specific activity as well. In Hempton's words, "I seek out places in nature much like a landscape photographer, but instead of recording light, I capture sound." In his ambitious *Dawn Chorus*, Hempton captured audio recordings of the dawn chorus of birds at different locations around the world, including Hawaii's Haleakala volcano, the outback of Australia, Sinharaja Forest Reserve of Sri Lanka, and Kalahari Desert of South Africa. Hempton states: "My art, by necessity, can occur only at the world's most remote places, far away from modern fossil fuel-driven, noise-polluted areas." Just as Hempton has set out to capture the salient experience of "nature at its most natural," Dawn Scarfe creates site-specific works intended to bridge the space between remote forest locations and urban domestic environments. In her *Bivvy Broadcasts*, Scarfe streams a real-time audio signal between a remote forest location and people located in urban areas. Similar to Hempton, Scarfe's objective is "to get enough distance from urban centres to reflect on the differences between urban and rural ambience, and to explore the imagined space of the forest as much as the physical reality." Hempton and Scarfe are proposing completely different solutions to a common issue which is clearly articulated by Hempton: "I think of myself more like a messenger, delivering something that we all understand once we hear it—Earth's music." He goes on: "it is our birthright to listen to nature undisturbed and reclaim our spiritual connection to our ailing planet."

Ximena Alarcón, in *Sounding Underground*, takes an altogether different approach in addressing the location theme using networking technologies and multimedia interfaces. Her work explores the sound worlds of the Paris, London, and Mexico City underground transport systems. Alarcón is interested in linking the outer sonic environments of these locations with the memories and feelings of commuters. Alarcón's work allows for the creation of virtual sonic environments derived from the originals "in a dynamic interaction with the complex sonic world composed by people, machinery, reverberant acoustics, and in a ritual of going underground." Alarcón describes these virtual sonic environments as spaces "where the rhythms, sound textures and gestures are together in a sort of interactive collage that invites people to find connections and open their imaginations for the depth of the meanings and feelings that arise from a shared urban underground infrastructure." In this sense, Alarcón is exploring the creation of virtual spaces that emerge through the memories and interaction of the commuters. In essence, it is a

new sonic space derived from the other sonic spaces. Along the way, Alarcón is challenging the commuter's way of listening. She is coaxing and encouraging the listener to reflect on the relationship of inner life and the outer sonic space.

As we are beginning to see, the artists in this book are drawn from broad and diverse backgrounds, and that diversity is reflected in their individual creative works. However, we are also beginning to see that within this outer world of diversity there exists a concealed world of similarity that unifies artists. In the essays contained in this book, the artist's words become an extension of the artist's work. As the artist's words lead us through his or her work, the careful reader will begin to discover reoccurring themes, continuity, and connections that appear, disappear, reappear, interweave, overlap, and often take circuitous paths to their final destination. In addition to some of the central themes already pointed out, environmental sound art explores a variety of issues, ideas, and connections with a clarity and directness that is comprehensible as art, as well as social, political, and scientific discourse. This scenario is further advanced by the artist's awareness and concern for environmental issues such as climate change, energy, and resource depletion. These concerns and sensibilities have unified artists around the globe, achieving a solidarity and clarity of purpose that is singularly unique and optimistic.

In many of the essays that appear in this book, an awareness and urgency for the preservation of the environment is foremost. As Jeff Talman points out, "It is unimaginable in this era to approach an environmental sound installation and not be sensitized to concerns of the general environment itself." David Monacchi echoes this perspective and as an environmental sound artist has carefully contemplated his role, relationship, and responsibility to the environment through his art. Monacchi recalls, "I had to determine how my art could be a platform and forum for environmental awareness, while maintaining a scientific and ecological methodology." Monacchi continues, "I felt compelled to invest my life in a sound-art project, which would promote public awareness on the most silent catastrophe of our times." Although the artists in this book have uniquely different approaches to achieving their objectives when it comes to environmental preservation, the issue remains paramount and is addressed in various ways. Andrea Polli's work in sonification is designed to reach the audience both aesthetically and realistically. Polli points out: "I believe that artists have the opportunity to create works that have an emotional impact and through touching the emotions of the audience, this work can affect environmental understanding and therefore behavior"

Another theme that occurs frequently in the works of the environmental sound artists is the notion of participation and the desire to cultivate a larger collective awareness. Leah Barclay states that: "In addition to composing music, I was interested in exploring ways to expand my artistic practice and engage communities in the creative process, essentially designing frameworks that would inspire others to listen to the environment and contribute towards cultural change." The need to reach out through art and to share the environment beyond one's singular perspective, to make contact, to extend, and to step beyond is exemplified in Dawn Scarfe's approach, in which she states: "I wanted to

explore the connections between broadcaster and remote listener. I hoped they might be in a similar restful position, listening together through the night, with varying degrees of awareness of the world around them." John Bullitt addresses the issue of reaching out to a larger collective more directly. Through his work in monitoring the seismic vibrations of the Earth, Bullitt sees the value in sharing these results. He states: "I continue to explore ways to bring the seismic sounds of Earth into people's ears and consciousness." To achieve his objectives, Bullitt launched a micropower FM station that allows people to "tune in to the deep sounds of Earth."

Many artists have integrated their environmental sound art with more traditional aspects of music performance and music making. This is a thematic thread that we see, in varying degree, in many of the environmental sound artists presented in this book. When introducing himself, David Rothenberg proclaims, "I play music with birds, whales, and bugs." Rothenberg recounts one of his early experiences when improvising on his clarinet: "I played along with a white-crested laughing thrush that really started to groove with my tunes." Likewise, Matthew Burtner pursues an approach in which he incorporates sonification and interactive acoustics. Most of Burtner's works are for staged musical performance. He describes his approach: "I am interested in how human imagination becomes embodied through environment, and so my music often involves emerging tools such as distance technology, social networking synthesis and spatialization in combination with human performers." Joseph Bertolozzi, in his work *Tower Music*, where he performs percussively on the physical structure of the Eiffel Tower, states that: "I wanted to write pieces that the public would hear as music first." Bertolozzi refers to his work with the Eiffel Tower as "fixed musical compositions that can be reproduced live in concert using only the sounds created by physically playing the surfaces." Aki Pasoulas also works with more traditional musical forces including *acousmatic* music, which is a form of electronic music designed for loudspeaker playback. While Pasoulas works with a variety of sonic materials and theoretical principles derived from traditional compositional techniques, he states: "I do not consider myself exclusively an environmental sound artist; however, my practice as a composer often involves sounds from our surrounding environment" While Pasoulas does make it clear that he operates more from the perspective of a traditional composer, he states that his "composition is a celebration of the richness of the sounds that surround us and the power of their associations."

As we continue to explore the thematic connections present in the creative works of these environmental sound artists, we come to appreciate an almost universal theme, which strategically presents itself and emerges, to some extent, in the work of almost every artist. In most cases the artists are asking us to simply open our ears and listen! David Dunn's work, for example, focuses on listening strategies in both aesthetic and scientific contexts. According to Dunn: "It occurs to me that one of the best uses of my time, as a composer, is to simply listen to some of nature's changing messages and pass them along to others." Likewise, Bruce Odland asks: "Could we, for instance, learn to think with our ears?" Bernie Krause states: "From my perspective, one more informed by sound

than sight since from early childhood my vision has not been terrific, the world has been primarily informed through what I hear."

Hearing the environment and opening our ears and minds to both the unconcealed and subtly hidden nuances of the world around us offers the observer a fulfilling experience. The environmental sound artist puts into motion specific conditions, expectations, and anticipations, and all that is asked in return is that we "listen." Marty Quinn's sonifications, while exploring the relationship between data and music, address the potential in our perceptual abilities and our potential for listening: "I believe we have only begun to explore the perceptual opportunities afforded by transforming data into music and the limits of such musical perception by our brains." Similarly, China Blue clearly articulates the significance in hearing the environment: "The underlying theme of my work is revealing the hidden vibratory structures of our world and how they shape our lives." In *The Place Where You Go to Listen,* John Luther Adams conceived the installation as "a contemplative space for tuning our ears to the unheard resonances of the earth and sky." Hearing means paying attention, and this attention can lead to awareness, contemplation, understanding, and insight.

Within the vast and varied world of environmental sound art, we are able to see common threads emerge that link all of the artists. The artists engage in creative activities intended to increase our awareness of the environment through sound. In this book, each artist presents an individual story. Some are biographical, others technical, many philosophical, and some are based on a combination of perspectives. The result is not a collection of standardized and homogeneous essays but a collection of individualized and introspective writings that, when taken as a whole, coalesce into a body of writings that offer a penetrating and self-examining view of environmental sound art. This is not a book of hymns but an encyclopedic journey exploring the multiplicity, assortment, conviction, and range of ideas as articulated by the artists. The essays contained in this book are extensions of the artists' creative work. The artists lead us through their process and give us a glimpse into the reasoning and methods at work in their art. This glimpse reveals a relationship that is balanced between the rational and the mysterious. The environmental sound artist works both covertly and openly as a liaison to the environment. In essence, the environmental sound artist alters our perception and understanding of the environment by persuading us to pay attention to it.

We value the diversity and the multiplicity of artistic personalities represented in this book and realize that such diversity would surely result in a wealth of topics, goals, drives, objectives, themes, and writing styles. No attempt has been made to restrict the style of writing for the sake of conformity or academic protocol. This would surely be a contradiction to the very nature of allowing the contributing artists to write "in their own words." As a result, the essays are endowed with originality, vernacular freshness, and authenticity.

So where is this art form leading us? Can it be halted by geographic boundaries, political philosophy, technological logistics, economics, or stylistic trends? Does it bend

more toward the finite or toward the infinite? Are we on the back edge of something ephemeral or on the front edge of something vital and imperative? The answers to these questions are unknown. But the clues are evident in the imaginations, actions, and works of environmental sound artists worldwide. In this book you will become acquainted with the ideas, thoughts, and reflections of many artists, articulated in their own words. If this book achieves one goal, it is to inspire a new generation of environmental sound artists.

If it inspires only a single new artist, we have all gained.

Frederick Bianchi
V.J. Manzo

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Introduction

Environmental sound art is a relatively new term which has yet to be properly defined; however, it can be broadly understood as encompassing a collection of artistic practices in which environmental sound constitutes the medium, material, and/or subject matter for the work. But what exactly do we mean by *environmental sound*?

Sound, in its physical sense, is the phenomenon of waves of vibrating particles—*sound waves*—resulting from the occurrence of a dynamic event in space and time. In this sense, all sound is *environmental*, since it cannot exist independently of a physical context and a propagating medium—solid, liquid, or gas—for it to travel through. When we use the term *environmental sound*, however, we are not referring to a specific kind of sound, nor to a specific kind of environment, but to a specific *conception* of sound in which it is defined by its environmental context: thus, the tweeting of birds and the rustling of leaves in the wind are part of the environmental sound of a forest; the hum of air conditioning and the tapping of computer keyboards are part of the environmental sound of an office.

In order for sound to become more than just the physical phenomenon of vibrating particles, however, it must also be received by a sentient being who is able to cognitively translate those vibrations into psychological experience; thus, the actualisation of sound as an experiential phenomenon also necessitates the existence of the *listener*. For humans, as for most other creatures, listening to environmental sound is key to the way in which we experience and understand the world around us, providing us with a complex web of information that lets us know what is happening, where it is happening, and what may be about to happen next. Unlike the visual, which is experienced as something outside of the body and at a remove from the self, sound is an intensely personal, sensual experience that penetrates our bodies and gets inside our heads.

Sound art, meanwhile, is a wide field with fluid boundaries, encompassing works in a variety of media that share a core concern with issues around sound and listening. The

dividing line between *sound art* and *music* can sometimes be unclear; indeed, prior to the term gaining currency in the late 1990s, works that would now be considered sound art were generally categorized as *experimental music*. Today, the distinction between the two often depends upon one's individual understanding of the terminology, and it might thus be proposed that it should ultimately be left to the individual to interpret works in whatever way proves most conducive to the ability to receive, understand, and appreciate them on their own terms.

The environmental sound artists featured in this book create works that range right across the spectrum of music and sound art, employing a wide variety of practices and approaches including (but not necessarily limited to) soundwalking, field recording, electroacoustic composition, instrumental music, sonification, sound sculptures, direct interactions with the soundscape, and the creation of immersive sonic environments. Their work exhibits an equally wide range of purposes, meanings, and messages: some aim to provide new insights about a particular environment; some investigate the sonic characteristics of particular spaces, elements, or phenomena; and some touch on cultural, sociopolitical, or environmental issues. What all these artists share, however, is the fundamental desire to draw our attention to the sounds that surround us, encouraging us to practice conscious, focused listening as a means to enhance our knowledge, understanding, and appreciation of the world we live in.

History of Environmental Sound in Music and Sound Art

The origins of environmental sound art can be traced back as far as the Neolithic era, with the field of *archaeoacoustics* having discovered evidence of humans sonically engaging with their environment through the creative use of acoustically rich spaces and resonant rocks. Environmental sound has formed a key part of the musical and sonic expression of human cultures ever since, and examples can still be found all over the world, such as in the throat singing of Tuva, which imitates the environmental sounds of the steppes; the *lift-up-over-sounding* of the Kaluli people of Papua New Guinea, whose music imitates and blends with the symphony of the rainforest; or the polyphonic yodeling and water drumming of the Bayaka pygmies of the Central African Republic, whose culture rests upon their close relationship with the soundscape of their forest home.

Western musical history, meanwhile, is replete with evocations of environmental sound in works such as Janequin's *Chant des Oiseaux* ("Birdsong") (1528), Vivaldi's *Four Seasons* (1723), Beethoven's *Pastoral Symphony* (1808), Saint-Saens's *Carnival of the Animals* (1886), and Messiaen's *Reveil des Oiseaux* ("Awakening of the Birds") (1953). A compositional technique common to these works involves the adoption of environmental sound as a musical *model*, whereby the core pitched, rhythmic, and dynamic elements of sounds are notated and imitated by instrumental voices, highlighting their natural musicality.

One thing that the history of environmental sound in Western music makes clear, however, is that up until the twentieth century it was generally only the sounds of the natural world that were thought worthy of aesthetic appreciation; and of those, it was only sounds that exhibited clear harmonic or rhythmic characteristics, such as birdsong, which were considered *musical.* In 1913, Italian artist Luigi Russolo set out to challenge these conventions in his Futurist manifesto *L'arte dei Rumori* ("The Art of Noises"), in which he argued that the sonic palette of modern Western music should be expanded to reflect the inharmonic noises of the urban, industrial environment with which humankind had become increasingly surrounded. To realize this, he designed and built a set of instruments named *intonarumori* ("noisemakers"), which produced a variety of noises in imitation of factories, industrial machinery, cars, and airplanes and for which he composed a number of works which were performed in a series of riot-provoking concerts.

In the 1920s, French composer Edgard Varèse began incorporating a wide range of noises into his orchestral works, including sirens, wind machines, theremins, and huge batteries of percussion, while *Déserts* (1950–54) featured tape recordings of noises from factories and *Poème Électronique* (1957–58) was a collage of various environmental and electronic sounds. Early on in his career, Varèse coined the term *organized sound* to refer to his compositions and proposed that it be adopted as the new definition of music in order to reflect the expansion of its boundaries in the twentieth century.

This suggestion was later echoed by American composer John Cage, who asserted in a 1937 lecture that all sounds, whether instrumental, electronic, or environmental, could be understood and appreciated as music, and advised that if the word *music* was too sacred to people, they could substitute the term *organization of sound.* Cage's most famous (and much misunderstood) work *4'33"* (1952) involved the performer sitting at a piano for the duration of the stated time without playing a note, creating a situation in which the audience practiced the attentive listening demanded by the concert setting, but where, in the absence of any music performed on stage, their listening became refocused upon the myriad environmental sounds that occurred in the space during that timeframe—sounds that, for Cage, constituted the music.

In 1969, Canadian composer R. Murray Schafer expanded upon Cage's ideas in a pamphlet entitled *The New Soundscape,* in which he characterized the environmental soundscape as a vast symphony of which we are all composers and encouraged the practice of focused listening as a means to develop an aesthetic appreciation of environmental sound. Three years later, together with colleagues at Simon Fraser University in British Colombia, Schafer established the World Soundscape Project (WSP) to study the dynamics of soundscapes, the ways in which they were changing, and the effects they had upon their inhabitants. These concerns soon coalesced into the new discipline of *acoustic ecology,* detailed by Schafer in his hugely influential 1977 book *The Tuning of the World.* Today, acoustic ecology constitutes a significant international movement, centered on the World Forum for Acoustic Ecology, and remains an important influence upon many contemporary environmental sound artists.

Field Recording–Based Approaches

A key element of the WSP's work in studying and documenting the soundscape involved the tape recording of environmental sounds, a practice known as *field recording*. In 1877, exactly one hundred years before the publication of *The Tuning of the World*, Thomas Edison's invention of the phonograph had made it possible to capture environmental sound and play it back, and as recording technology has evolved, from the phonograph to the magnetic tape used by the WSP, and onto today's digital recording devices, field recording—sometimes referred to as *phonography*—has become an increasingly widespread practice, and one that forms the foundation for much environmental sound art.

For some artists, field recording constitutes an end in itself. Their recordings may focus upon the sound of a specific object, creature, phenomenon, or event or take in an entire sonic environment; their aims may include exposing audiences to sounds or soundscapes they would not normally hear, revealing something about the world through its sounds, or preserving endangered sounds for posterity, highlighting what we stand to lose if they disappear completely.

Some artists incorporate field recordings of environmental sounds into musical compositions, treating them as an instrumental voice. Italian composer Ottorino Respighi was the first to do this, featuring a phonograph recording of a nightingale at the conclusion to the third movement of his 1924 symphonic poem *Pini di Roma* ("Pines of Rome"). French composer François-Bernard Mâche went a step further in his 1968 work *Rituel d'Oubli* ("Ritual of Forgetting"), combining recordings of environmental sounds including birds, bees, wind, and water with instrumental parts modeled on the same sounds. Other works, such as Alan Hovhaness's *And God Created Great Whales* (1970) and Einojuhani Rautavaara's *Cantus Arcticus* ("Arctic Cantus") (1972), featured instruments not only imitating, but also accompanying and harmonizing with, recordings of whalesong and birdsong.

Other environmental sound artists subject field recordings to various degrees of electronic manipulation, using them as material for *electroacoustic* compositions, an umbrella term for works composed from electronically edited, processed, or transformed sounds. Within this field exist several subgenres, two of which represent approaches commonly utilized by environmental sound artists: *musique concrète* and *soundscape composition*.

Musique concrète, developed in the late 1940s by French composer Pierre Schaeffer, involves editing and transforming recorded environmental sounds in order to disguise their original identity and turn them into abstracted *sound objects* which can then be redeployed as musical material. Schaeffer adopted the Pythagorean term *acousmatic*—meaning sounds whose source is unseen—to describe these sounds, and he named the resultant listening experience *reduced listening*, meaning listening with one's focus reduced to the sound's inherent sonic characteristics as opposed to its real-world identity and context.

Soundscape composition, in contrast, is defined precisely by its deliberate preservation of sounds' real-world origins and associations. The genre was developed and defined in the 1970s by Canadian composers and WSP colleagues Barry Truax and Hildegard Westerkamp; however, its origins can be traced back to German filmmaker Walter Ruttman's 1929 sound work *Wochenende* ("Weekend"), an 11-minute montage of environmental sounds recorded in Berlin which was intended as the radio equivalent of the popular cinematic *city symphonies*. Following the development of musique concrète in the 1940s, Schaeffer's acousmatic aesthetic became the generally accepted principle for composing with field recordings; however, in 1970, French composer Luc Ferrari controversially broke with this convention with his composition *Presque Rien No.1—Le Lever du Jour au Bord de la Mer* ("Almost Nothing No.1—Daybreak at the Seashore"), a work that consisted of recordings of the soundscape of a harbor edited into twenty-one minutes of highlights, suggesting that undisguised environmental sounds were worthy of aesthetic appreciation in themselves. In 1973, the WSP released an album entitled *The Vancouver Soundscape*, containing a mixture of field recordings and edited soundscape compositions. Upon its rerelease on CD in 1996, it was accompanied by a follow-up album, *Vancouver Soundscape 96*, which demonstrated how the genre had developed in the intervening years, containing works that moved beyond simple editing, employing a range of processing techniques to transform the environmental sounds used, often drawing out harmonic or rhythmic elements to emphasize their natural musicality. In many ways, these developments moved soundscape composition closer to the aesthetic of musique concrète, but with the crucial difference that, however radically the environmental sounds were transformed, their origin was always at some point made clear in order to stay true to the genre's defining principle of engaging with listeners' perceptions of the sound's real-world identity and environmental context.

Site-Specific Approaches

Not all environmental sound artists operate through the medium of field recordings, however: many employ a variety of methods to engage directly with the sounding environment. One of the simplest of these is the *soundwalk*, which involves walking through a specific location while practicing focused listening to its environmental sounds. The WSP frequently carried out soundwalks as a means to encourage awareness and appreciation of the soundscape; however, they were not the first to do so. In *The Art of Noises*, Russolo had suggested that the reader cultivate an appreciation of urban environmental sounds by walking through a city, focusing upon what they heard rather than what they saw; in 1966, artist Max Neuhaus realized the first in a series of works entitled *Listen: Field Trips Thru Found Sound Environments*, in which audiences had the word *LISTEN* stamped on their hands and were guided through a sonically rich location such as a power station, subway, or busy street.

Some environmental sound art techniques hark back to the very earliest explorations of the sonic environment practiced by Neolithic humans, exploiting the sonorous potential of natural or manmade objects or structures, or exploring the acoustic properties of spaces, using sound to activate the resonances of a given environment. For his highly influential work *I Am Sitting in a Room* (1969), American composer Alvin Lucier recorded the sound of his voice speaking in a specific room, then played it back into the room and recorded it again and continued to repeat the process, creating a feedback loop in which the reverberation created by his voice was increasingly emphasised, until the words he was speaking became completely obscured by a harmonic wash of tones arising from the natural resonances of the space. American composer Maryanne Amacher, meanwhile, created a series of works entitled *City Links* (1967–1981), in which she used telephonic or radio technology to transmit the sounds of one space into another, dislocating them from their original environmental context to create a new space in which the sounds of the two environments mingled with one another.

Another approach involves the creation of site-specific works, designed to be heard within a specific place in order to complement its environmental soundscape. R. Murray Schafer's 1979 composition *Music for Wilderness Lake*, scored for twelve trombones, was performed with the musicians standing around the shores of a lake at dawn and at dusk in order for the performed music to mingle with the environmental sounds, an approach that he would subsequently expand upon for several of the site-specific music theater works in his mammoth *Patria* cycle (1966–). The same year also saw the composition of the first work in Italian composer Walter Branchi's *Intero* ("Whole") (1979–), an ongoing series of electronic works designed to be performed in specific environments and to work in harmony with their natural soundscape, in order to achieve what Branchi characterizes as *eco-music*.

Some artists go a step further, with approaches that aim to realize a genuine *two-way* interaction with environmental sounds. One early recorded example was a 1924 BBC Radio broadcast during which cellist Beatrice Harrison sat in her garden and played a program of popular songs, into which a nightingale appeared to join. In 1976, American composer David Dunn took a more scientific approach with his work *Mimus Polyglottus*, studying the patterns and frequencies of sounds made by mockingbirds and using what he learned to produce a tape of frequency-modulated square waves, which he then played back to a mockingbird, who began to imitate and interact with the sounds on the tape. This led to a series of site-specific works in which Dunn attempted to provoke sonic interactions between humans, nature, and technology through various combinations of live performers, electronic sound, and, in a method comparable to that used by Alvin Lucier, gradually evolving feedback loops achieved by repeatedly recording the environmental soundscape and playing it back into the space.

Other environmental sound artists do not work with the sounds of existing environments at all but create works that function as autonomous sonic environments in themselves. A pioneer of this approach was Iannis Xenakis, a Greek composer and architect who designed and constructed a number of immersive audiovisual environments,

beginning with the Philips Pavilion at the 1958 Brussels World Fair and continuing with a series of even grander constructions between 1967 and 1978, which he termed *polytopes*, housing multisensory spectacles of lights, film, and multichannel diffusions of his own electroacoustic compositions. In 1966, meanwhile, American composer La Monte Young opened his *Dream House*, an immersive sound-and-light environment in which sustained tones were played 24 hours a day in perpetuity and which is still in operation half a century later.

Sonification-Based Approaches

A very different set of approaches involves a technique known as *sonification*, in which nonaudible phenomena are translated into sound via a variety of methods. Perhaps the simplest form of sonification is the creation of instruments, or *sound sculptures*, which are activated by natural environmental forces, of which the most well-known example is the *Aeolian harp*, a stringed instrument resonated by the wind. The concept of the Aeolian harp has its origins in ancient Greek myth, but its invention is generally credited to seventeenth-century German scholar Athanasius Kircher, who wrote about it in his book *Musurgia Universalis* (1650) and built a number of working models. More recently, sound artists such as Leif Brush, Harry Bertoia, Alan Lamb, and Max Eastley have constructed large-scale Aeolian instruments, including harps, flutes, bells, and chimes, as sculptural sound art installations.

Another form of sonification involves mapping visual or numerical data onto sonic or musical parameters. One example is *millimetrization*, invented by Russian music theorist Joseph Schillinger, which involves the transcription of the contours of a picture onto a graph and its translation into musical pitches and melodic lines. Brazilian composer Heitor Villa-Lobos used this technique to compose his *New York Skyline Melody* (1939), *Melodia da Montanha* ("Mountain Melody") (1942), and *Symphony No.6: Montanhas do Brasil* ("The Mountains of Brasil") (1944); a comparable technique was later employed by John Cage for his *Atlas Eclipticalis* (1961–62), for which he superimposed musical staves over star charts, allowing the position of the stars to determine the music.

Sonification may also be used to translate dynamic environmental phenomena into sound, either in real time or after the event. An early example of this type of sonification is the Geiger counter, invented in 1908, which utilizes a gaseous reaction to detect radioactive particles and express them as audible clicks. Pioneering artistic applications, meanwhile, include Alvin Lucier's *Music for Solo Performer* (1965), in which the performer's alpha brainwaves are detected with EEG electrodes and used to vibrate percussion instruments, and Charles Dodge's *Earth's Magnetic Field* (1970), in which data describing the fluctuations in the eponymous phenomenon over the course of a year were used to determine the pitch, tempo, and dynamics of electronically synthesized sounds.

Closely related to sonification is *audification*, which involves bringing high-frequency ultrasonic or low-frequency infrasonic sound waves into the range of human

hearing; thus, as opposed to sonification, in which data or phenomena are translated into third-party sounds, audification makes the actual sounds produced by the phenomena themselves audible by transposing them into a higher or lower pitch. Harvard physicist G. W. Pierce pioneered ultrasound technology in 1937 with his invention of the *sonic detector,* which used a modified AM radio receiver to transpose high-frequency ultrasound down into the range of human hearing and was used to demonstrate how bats used echolocation to navigate and catch prey. The technology was used by Alvin Lucier in his 1968 work *Vespers*, which involved performers mapping the dimensions of a room through the use of handheld echolocation devices, while fifty years after Pierce's invention, audifications of bat echolocation sounds were used by German composer Wolfgang Müller in his 1987 work *BAT*. At the other end of the spectrum, audifications of low-frequency infrasound made by animals such as whales and elephants, as well as that resulting from meteorological phenomena such as earthquakes, volcanoes, lightning, ocean waves, and icebergs, have been used by a number of artists as the basis for sound works.

Environmental*ist* Sound Art

The aim of this introduction has been to highlight some of the core approaches and techniques involved in contemporary environmental sound art; however, art is never a purely technical exercise, and of perhaps even greater importance than the techniques that artists employ are the messages that they communicate, or the philosophies that they express, through their work. This is something that is generally best left to the artists themselves to explain; however, one significant trend that is worth briefly mentioning here is the use of environmental sound art to express environmental*ist* concerns.

The artistic exploration of environmental or ecological issues can be traced back to the late 1960s and early 1970s, when the coalescing of the modern environmental movement prompted artists such as Joseph Beuys, Agnes Denes, Helen and Newton Harrison, and Hans Haacke to respond with the first examples of what has become known in recent years as *eco-art*. As mentioned earlier, the development of acoustic ecology at around the same time was also, in part, a response to the environmental issues indicated by changes in the soundscape; however, as a field defined by its concern with the *acoustic* environment, its focus was largely upon noise pollution and the homogenization of the soundscape rather than wider environmental issues. In recent years, however, the significant escalation of global environmental concerns has prompted an increasing number of composers and sound artists to directly respond to issues such as biodiversity loss, pollution, sustainability, global environmental justice, and climate change, through their creative practice, forming a growing movement of environmentalist—or *ecoacoustic*—sound art.

Whether or not it is explicitly environmental*ist*, however, environmental sound art is at its core a deeply experiential art form, which, in all of its various guises and permutations, can help us to rediscover our crucial and fundamental connection to the environment through reattuning us to its sounds. It can be educational, teaching us new things

about the world we live in; it can also be transformative, enabling us to hear and understand it anew and prompting us to reimagine how it could be. The diversity of practices and approaches exhibited by the environmental sound artists featured in this book results in a rich and varied output of works that cross multiple disciplines and artistic media but which are fundamentally linked by their ability to facilitate a new, aesthetic appreciation of the sounds that surround us, imploring us to open our ears as a means to foster a heightened awareness, a deeper understanding, and an enriched relationship with the sounding world, as it dynamically reverberates around us, through us, and within us.

Jonathan Gilmurray

Andrea Polli works at the intersection of art and science, creating art related to environmental science since 1999, when she began collaborating with atmospheric scientists on data sonification. In her work, Polli seeks to establish an emotional connection and impact with her audience as a way of increasing awareness of climate issues. Through interdisciplinary collaborations, Polli experiments with performance, interactive and Web art, digital broadcasting, and mobile media as a means to engage and inform the public.

Polli is an Associate Professor of Art and Ecology at the University of New Mexico, where she directs the Social Media Workgroup research lab. Her work has been recognized by the NSF, NEA, NYFA, and Fulbright, and she has worked with the NASA/Goddard Climate Research Group and the National Center for Atmospheric Research. She holds a doctorate from the University of Plymouth, and her latest book (coedited with Jane D. Marsching) is *Far Field: Digital Culture, Climate Change, and the Poles.*

1

Sonifications of Global Environmental Data

As has been seen in recent tsunami, hurricane and forest fire disasters, many lives depend on the interpretation of global information. Developing a language or series of languages for communicating this mass of data must evolve, and part of that evolution must include the work of artists. The interpretation and presentation of data using sound is part of a growing movement in what is called *data sonification.*

How is the artistic process of transforming data different from the process of transforming physical material? Like a photograph, a data set is a representation, but unlike a photograph, this representation can be entered, explored and transformed. A data set can be experienced, but unlike a physical-world experience, it can be replayed from various points of view and under different conditions. Simulations are tested against the real world and results either confirm the model's accuracy or force scientists to reconsider and redesign. In some cases the simulation precedes and may even cause events in reality. Scholar and artist, Brett Stalbaum, defines one of the most important roles of a contemporary database artist as the projection of meaning onto meaningless data streams. This process mirrors the interpretation of data in the sciences, which is also a search for meaning.

I believe that artists have the opportunity to create works that have an emotional impact and through touching the emotions of the audience, this work can affect environmental understanding and therefore behavior. This is critically important now as we face the problem of global climate change, a much more difficult and complex problem than even the problem of the ozone hole. In my own work, I have tried to use the sonification of climate and weather data and the visual impact of natural imagery to have a kind of emotional impact and raise awareness of climate issues.

I have been creating artworks about environmental science issues since 1999, when I first began collaborating with atmospheric scientists on sound and sonification projects. Since then, I have created several major media projects in collaboration with scientists. This includes work about climate change in New York City with the NASA/Goddard Institute Climate Research Group, as well as work using real-time air quality data with

FIGURE 1.1 Polli recording at Williams Field, McMurdo Station, Antarctica (2007).

scientists and engineers at the National Center for Atmospheric Research and the national AirNow agency.

Heat and the Heartbeat of the City

Earth's atmosphere is becoming warmer, and a rise in global temperatures is already causing sea levels to rise around the world. This is likely to bring an increase in hurricanes and tsunamis that Earth may already be experiencing. In 2004, I worked with climate change data for the New York City region in collaboration with Dr. Cynthia Rosenzweig, Dr. David Rind, and Richard Goldberg at the NASA Goddard Institute for Space Studies and the Columbia University Climate Research Group. These scientists created an atmospheric model of the city that is one of the most detailed models of any urban area. The model allows them to predict how climate change will affect New York and the surrounding suburbs. I created a series of sonifications attempting to convey the physical experience of the increasing temperatures.

Heat and the Heartbeat of the City is a web site that presents a series of sonifications (musical compositions created by directly translating data to sound) that illustrate these dramatic changes focusing on the heart of New York City and one of the city's first locations for climate monitoring, Central Park. The data sonified is actual data from summers in the 1990's and projected data for the summers of New York in the 2020's, 50's, and 80's using an atmospheric model of the city. As you listen to the compositions, you will travel forward in time at an accelerated pace and experience an intensification of heat in sound. All the data

was formatted especially for the creation of sonifications. *The Heat and the Heartbeat of the City* site also includes excerpts from interviews with scientific collaborator, Cynthia Rosenzweig, of the NASA Goddard Institute for Space Studies and Columbia University.

In particular, the *Heat and the Heartbeat of the City* sonifications focused on expressing the effect of consecutive days over 90 degrees Fahrenheit during the summer months. If the number of consecutive days averaging over 90 degrees increase, this will increase the intensity of the sound. The sonifications were designed to emphasize the days over 90 degrees Fahrenheit, an uncomfortable day. I used a subtractive approach, starting with a noisy sound signal and reducing the noise for more comfortable temperatures. The noise was designed to be somewhat uncomfortable, to try to make people feel the difficulties, discomfort, and the actual problems that will result from global warming. Maybe, in some way, they will be convinced to think more seriously about the issue.

As a scientist collaborating with an artist, Dr. Rosenzweig is interested in how people can experience data in new ways. She states:

> ... we are so limited in the ways that we use our data. Basically we have a number of ways that are very statistical, certainly very mathematical and very useful, and then we represent the results of those statistics in graphs and tables. That's one way, and then we do have visualizations, for example an animation of the warming, using colors from yellow to red to deep brown over the decades. But that's it. It's really quite limited. So working on the sonification project you realize that when you hear something, you're able to understand the data in a new way, and that's what has been very fascinating.

In addition to the web site, the project has been realized as a multi-channel sound installation presenting climate change throughout the NYC region in the summers from 1990–2060. The project is also realized as a stereo speaker or headphone installation.

N.

Climate change in the Arctic is an important indicator of global climate changes. In 2005, English artist and programmer, Joe Gilmore, and I collaborated to create *N.*, a real-time online sonification and visualization of the Arctic. For this project, we worked with daily data gathered and formatted by our scientist-collaborator-meteorologist and convective snow and ice specialist, Dr. Pat Market, of the University of Missouri. We also used online data from the National Oceanic and Atmospheric Administration's Arctic Research Program. The format of the data was in the form of a sounding every 12 hours. That is, information about the weather from sea level to the top of the atmosphere as if you were taking a trip on a weather balloon.

To more effectively do the complex real time data interpretation in the *N.* installation, and to help others involved in art and science collaborations, computer programmer

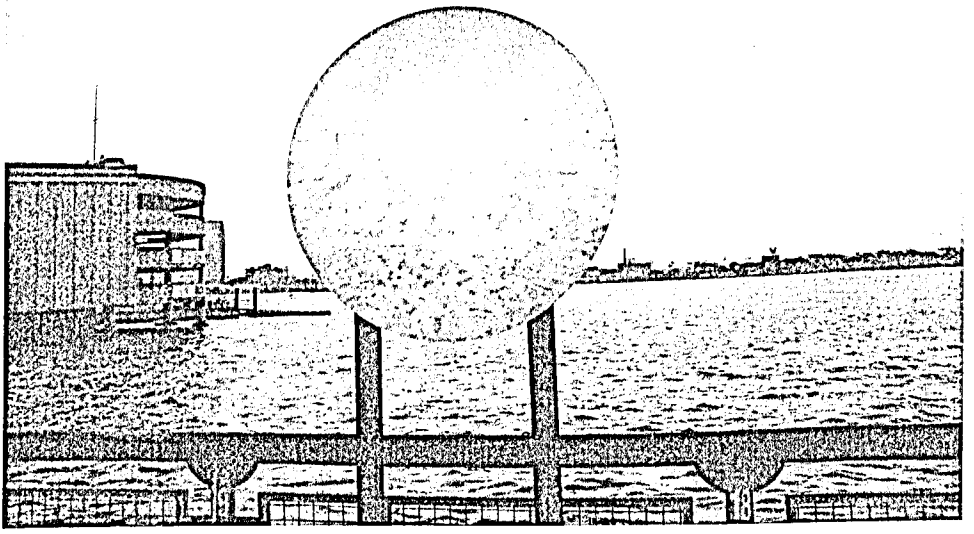


FIGURE 1.2 *N.* at the Solar One festival in New York City (2006).

and video artist, Kurt Ralske, and I developed a custom piece of software for use in conjunction with Max/MSP. We have also made this software and its source code freely available to other artists.

Aesthetically, the sonifications combined my subtractive approach with an additive approach by Joe, in which simple sine waves and other signals were combined and transformed based on the data. The combination created a rich soundscape to represent the complexity of weather at the North Pole.

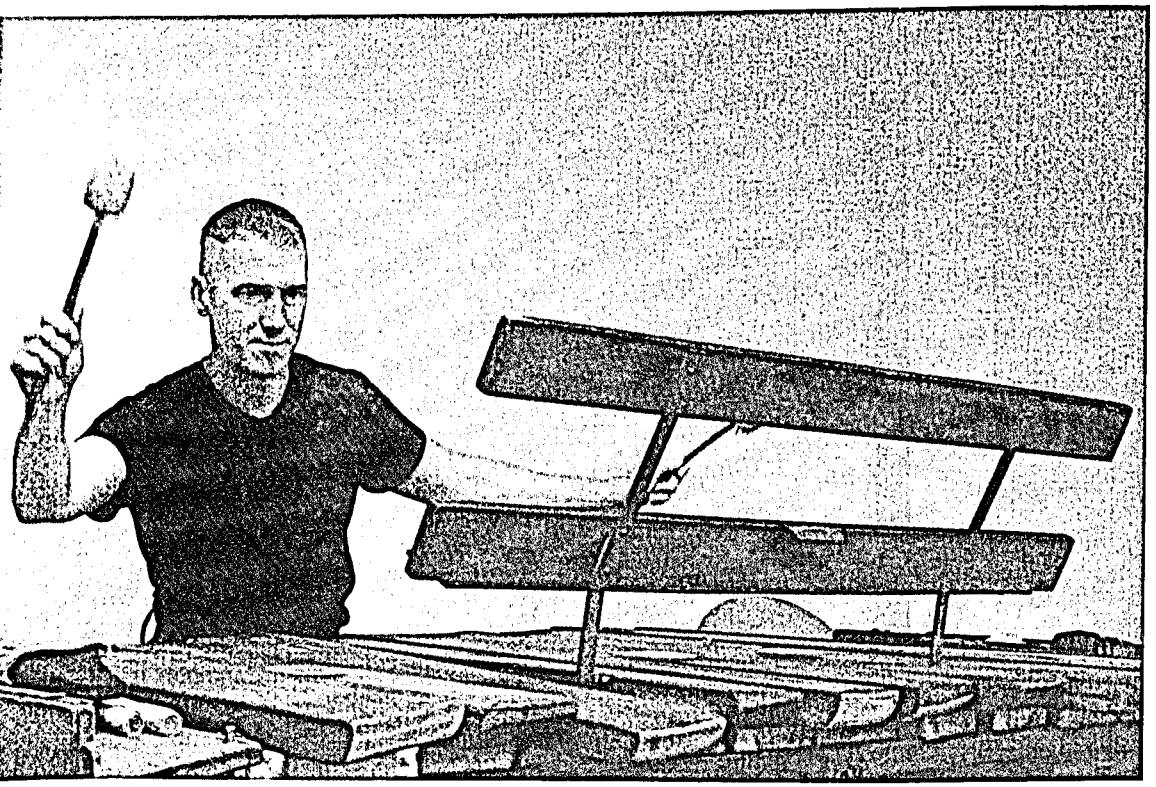
In the two sonification projects, *Heat and the Heartbeat of the City* and *N.*, I used all the data the scientists provided for each parameter directly in order without adding or subtracting data. Except when necessary, I used a linear interpolation algorithm to obtain a smoother transition between data points. The data itself, even in its raw state, is not "reality" any more than the sonifications are "reality." The scientists I have worked with will agree. For example, in the case of the *Heat and the Heartbeat of the City* climate sonifications, the data was again modeled, and there were actually several possible models that the scientists were looking at. The scientists chose the most conservative model for the sonifications. In other words, the model that showed the least amount of warming. But, having conservative results doesn't automatically make the model any more accurate than the other models used.

Even real time data like that used in *N.*, is not seen by the scientists as accurate until there is a chance to view and verify it. Automatic data capture is subject to error, so scientists have to review the data before its "official" publication. I was interested in real-time data, warts and all, so I accepted the possibility of error as a part of the piece. An analogy

FIGURE 1.3 Polli at Williams Field, McMurdo Station, Antarctica (2007).

that might describe how I have come to think of the sonification of data is the *eyewitness.* An eyewitness has experienced an event and has a much more accurate idea of what has happened than someone who hasn't witnessed the event. However, an eyewitness also has limitations. An accurate picture of an event is formed by a combination of the eyewitness, physical evidence, other witnesses, etc. This is the same process that happens with the data itself. The scientists spend a lot of time comparing and contrasting the data with various model results, satellite images, and other information to try to get an accurate picture. Sonification is just another piece of that puzzle. Can an artistic sonification be beneficial to science? An analogy might be an artistic crime scene photograph or sketch. Although it is an artwork with a point of view, it is still likely to contain useful information.

I believe that an active engagement with data models and databases is an important aspect of working in this medium. Through my collaborations with scientists, I have tried to learn as much as possible about the data in order to translate it more effectively. I have also combined sonifications with interviews with scientists, articles, and other textual information in order to add context and meaning to the work. Brett Stalbaum sees the database not as a static subject on which an artist projects meaning, or even as a malleable piece of "clay" transformed by an artist. He sees it as a "catalyzing factor in the conversation." He optimistically states that "data and control systems provide a channel through which ecosystems are able to express an influence in favor of their own protection." However, in order for the expression of the data to be heard, we have to be listening.



Philip Blackburn's works have been heard in harbors, state fairs, forests, coming out of storm sewers, as well as in galleries and on concert stages. His work invites the listener to *tune in* to the richness of the sonic world that surrounds us. Blackburn believes that we should let our ears guide us as we navigate through the environment, allowing us to reconnect, once again, and to be startled by what we hear. Refusing to be limited by traditional ways of thinking, he has incorporated brainwave sensors, plants, and dowsing rods in performance, as well as balloon flutes, car horns, conch shells, and wind-powered harps.

Philip Blackburn was born in Cambridge, England, and studied music there as a Choral Scholar at Clare College. He earned his PhD in Composition from the University of Iowa, where he studied with Kenneth Gaburo and began work on publishing the Harry Partch archives. He has worked at the American Composers Forum since 1991, running the innova Recordings label.

2

Sewer Pipe Organ

It was always a good family outing from my childhood village in England to venture over to Uffington's White Horse Hill, where the inscribed chalk horse has been galloping over the downs since prehistory. As we neared the mound where St. George slew the dragon, we often stopped off in someone's little yard in Kingston Lisle. There sat a sizeable chunk of pockmarked stone with natural boreholes in it and a wet notice board that indicated this humble rock was the Blowing Stone used by King Alfred to call his troops from the surrounding hills for the Battle of Ashdown against the Vikings in 871 AD. What budding trombonist could resist playing such a period instrument? Bending down, wiping the ancient flob away, and applying my best embouchure, the tone filled the surrounding hillsides, startling the racehorses more than scaring any Vikings, but still. The resounding landscape instantly reactivated a magical connection between the lungs, lips, rock, and a hard place. The unity of performer, instrument and auditorium sprang to life again. This one tone, coupled and amplified, had saved the world from the barbarians, at least for a while, so there must be something to its power.

Some years later, visiting Toby at the abandoned Liverpool docks, that same sonic curiosity drove me to remove the fizzy drink cans and debris from a giant abandoned foghorn that looked out across the Mersey. I proceeded to get down on the pavement, and blow with all my might. The Sunday strollers and layabouts snickered, but took note. What had been a sculpture silently witnessing the demise of maritime civilization now jumped to attention in awesomely long pressure waves, peaks and troughs. As we walked on, the gangs fought over who was going to try it for themselves, and we could hear the resonant hootings for hours afterward and far away. The foggy shroud of silence had lifted and the docks were vibrant once more. Once again, the community needed only a little prodding to become part of the world of phenomenal sound again.

Growing up as a chorister I had plenty of chances to perform music written for specific acoustics, spaces, and buildings. Gabrieli in San Marco or Tallis's 40-part motet in

King's Chapel seemed to couple the signal with the resonance in mystical ways, when the architecture, frequency response, distance, intelligibility, tempo, harmonics, and sonority all danced together. Spaces speak, reverb rocks, and tuning—in its largest metaphorical sense—has followed my compositional concepts, community agenda, and listening intentions ever since. The intrinsic relationship between people, places, and sound has only been broken in recent history. It might only take a nudge to reawaken those connections.

As a composer, I create public occasions for listening. There seems to be a plentiful supply of sound in the world, but all too rarely chances to focus on the receiving end; for creative consumption; for moments where our ears startle us into the present and allow us to hear as though for the first time. We routinely practice the art of tuning out urban noise, but don't often get to engage with sound in the foreground that might help us sharpen our awareness and make better choices about our living environment. Earbuds and traffic can mask the incessant inputs, but any moment—if seductive enough—can also be an opportunity for meditation, bringing us back to the present here and now. That is where I see a niche for my role in society as a composer; to engineer occasions for clarity and wonder that remind us we have ears at all. Maybe as better listeners to the clatter of civilization we can navigate our world more sensitively.

Our ears are always a little behind our eyes, but once we foreground them and notice the living webs of sound that we inhabit, we can't help but be astonished at the self-organization of the natural world.

As I walk through the jungles of Belize, day and night and in different seasons, it is clear that the sound tapestry of a dynamic, living, breathing ecosystem that has evolved over millions of years, is a better example of orchestration than any piece of concert music I know. The sounding critters, all virtuoso biomusicians, that live or die based on whether their mates hear them, find an acoustical niche that allows them to be heard through the dense, dark fullness. Ears connect to the central nervous system more directly than the eyes, and in the bush, where visibility is limited, the ears take precedence and it's easy to see why. That intense listening, as though your safety and lunch depended on it, is the condition to which my musical ambitions aspire.

Different cultures have different assumptions about what constitutes the best way of organizing society. Central African pygmy chants, Indonesian Gamelan, football anthems, and Viennese string quartets reflect the tribal values that gave them birth. Each is polyphonic, but incomprehensible to the other. The music is a living model of an ideal society for the duration of its performance.

When composers create a score and specify the notes to be played by the performers, they are also proposing relationships between the players, like a playwright making a script that tells actors what to do. By the same token, the reverse is just as plausible. What music, perhaps with a composer as catalyst, might arise by the dynamics of a particular

group of people? Might an audience become performers without even realizing it? Might group listening be considered a musical act?

In these days where everything is interactive, we might also question who controls the narrative: the composer or the audience? Both metaphorically and physically.

The experience of music is often described as a journey; it takes you on a prescribed pathway of moods. You might be physically sitting down, but the orchestra will carry you to faraway emotional places. Conversely, I see no reason why you might not move through a physical environment such as a city full of sounds, as though it were a giant installation, letting your ears rule your feet, and discover the place yourself, directed by whim, creating your own performance along the way. I did this with a (disguised) tape recorder in Havana, Cuba, in 2004 where the architecture and musical cultures are inseparable, and the soundwalk I took had all the components of an intentional symphonic structure that combined Spanish and African traditions in a dynamic equilibrium. Cuban music as it is experienced on its home turf is rarely less than half a dozen layers of musical elements bleeding into each other through the stone streets and courtyards. Without that context we are missing essential elements of understanding how that place, its people, and its music are related. So if the city itself is a symphony, how might I get to play with it?

While attending Sound Symposium 2003, a sound art festival in Newfoundland, I had the chance to write a piece for ships' horns. The harbor in St. John's, nestled between protective cliffs, receives ships from around the world every day; there is no way to predict how many, nor for that matter the pitches of their horns. With the blessing of the organizers, I wrote a score for up to eight horns, and a pair of trained honkers and timers boarded each vessel the next morning. That was the limit of control available to me as the composer. The harbormaster, flouting maritime regulations, used the emergency broadcast frequency to synchronize the downbeat and they were off. The intricately calculated bell-change patterns peeled through the port, bouncing off buildings and crags, but, since the stage was about 3 miles long and sound takes time to travel, each of the 250,000 residents of St. John's heard a different tune. Space became integrated into the structure of the work and the network of perceivers; the music became a sounding, inseparable from its location and yours. Einstein would have loved it.

Not content with the Harbor Symphony's practical, legal, and instrumental limitations, in 2012 I undertook a more elaborate project on the shores of Lake Superior. For the Duluth Harbor Serenade, I expanded the musical forces to include ship's horns (tooting their customary signaling language) and also lift-bridge alarm bells, foghorns, steam train whistles, a carillon, and clock chimes. These all sounded their usual patterns (but more densely) at 3 p.m. for six minutes while a flash mob performed a score using outdoor brass instruments, gongs, a chainsaw duet, and an opera singer. Apart from the headaches of arranging such an event, getting permission from the mayor and Homeland

Security, and documenting the show, the effects of subtly transforming the existing acoustic environment were ear-opening. Locals in the audience hear (and tune out) these endogenous sounds every day; changing their frequency and locations was enough to call attention to them. Non-natives watching the video documentation get a sense of the unique combination of elements that make up a sonic postcard that could only have come from Duluth. It is a piece without clear beginning or end; a sparser version of it is probably going on right now. It is also an event where musical markers yield to those of public art, where the work doesn't pretend to exist other than every citizen's personal experience of it.

While I have explored ways of sounding spaces above ground, I have been just as interested in going deeper. In 2003 at the invitation of the Cannon River Watershed Partnership, I developed a number of activities to bring attention to the underappreciated river that runs through Northfield, Minnesota. Inspired by those stenciled signs near storm drains that occasionally say "No dumping. Drains to river," I wondered if there might be an acoustic way to deliver a similar message. There was a drain guard on the road with an outflow about thirty feet away directly at the water's edge. On my next visit I took a large guitar amp and a CD containing a series of swooping impulse tones, which I placed at the opening, running back to the street to record the results. From this

FIGURE 2.1 Blackburn tests the resonance curves of a storm drain near the Mississippi River in St. Paul, Minnesota.

my friend and I were able to assess the frequency response curve of the pipe, the pitches it would reinforce and those it would dampen. I went home and created a mouth-organ based soundtrack that played in, out, and around those particular hot frequencies. On the day of the festival that piece was pumped back into the pipe. That's when the magic happened.

It turned out there were two gratings connected to that same pipe. When the mono sound source was played from the open end by the river it emerged, in phase, split into pseudo stereo, from both covers up at the road. By standing at the mid point of the two covers it appeared as if the sounds were being reassembled in your head. The reflections from the nearby bank and library likewise morphed the sounds and turned the space into a spider's web of standing waves visible only to the ear, best appreciated by rotating your head very slightly. A stick of incense hung burning in the drain and the effect was complete; people stopped and listened and sniffed and left a little more appreciative of the resonant underbelly of their hometown.

So when Public Art St. Paul in 2011 asked me for something to take place by the Mississippi River, I knew what I wanted to try. Capital cities have more complicated infrastructure than quaint college towns, and St. Paul is no exception. Built on limestone bluffs with natural springs and riddled with caves, I knew this would take more planning. I started with Bruce, sewer czar at the Public Works Department. Unaccustomed to working with artists, but game for a break from routine, he got out his large, esoteric maps overlaid with all the utility connections. One area looked promising, near the gym, a coffee shop and some condos; here was a labyrinth of water pipes with five openings over a large grassy area leading eventually to the river. Tests that summer with a boombox indicated that, sure enough, sound could travel where excess rainwater was originally intended.

The next task was to compose something poetically appropriate to come out of those drains. Playing abstractly, as in Northfield, with the resonant frequencies of such a multipronged construction was not going to be too effective. Raindrops, the quintessential sound of such drains, likewise were not going to add much unexpected drama. Since I couldn't decide between two ideas, I used them both: a soundscape suggesting steampunk Victoriana alternating with a rhythmic drone based on the 60-cycle hum of the electrical system.

The city has expanded vertically up, and also down, since the 1840s. Tunnels for drainage interlock with old passageways for silica mines, brewing operations, brothel and glacial aquifer access. This parallel city is invisible to all but a few workers and daredevil urban explorers. Hearing is a particularly good way to bring attention to these spaces because the ears have a better way of processing a sense of volume, material, and space than eyes do in the dark. If this were a subterranean city it would no doubt have sunken cathedrals, clanking machinery and turbines, looming factories, and a few lost children innocently playing in sooty yards. I pieced together a 25-minute collage of such sounds, culled

from homemade instruments and old recorded detritus, stretched beyond recognition. I conjectured that low rumbles would travel farthest down the pipes and give a sense of fullness while higher frequencies may get dampened, but still provide a sense of distance after being modulated through hundreds of yards of slimy concrete pipes. The structure of the composition was holographic so that an audience member passing by at any moment could hear something interesting, constantly evolving, but without missing any obvious beginning, middle, or end. This is where the composer in me fusses with musical form more than perhaps a pure sound artist might. Yet it is also this attention to nerdy musicality that gives me hope that the work might transfer to other contexts (such as a CD) later on.

The second movement is more geometrical, full of shifting mechanical rhythms and microtones. The organic, poetic associations are replaced in favor of clean patterns and pure proportions. Ever since Tesla invented AC and beat out Edison, our electrical supply has produced a steady 60Hz buzzing tone, a slightly sharp B-flat. Except in England, where it's a G, our lives are saturated by this drone until, like the harmony of the spheres, we tune it out from everyday consciousness. Until a loud refrigerator, street lamp on a muggy night, or TV transformer wakes us from our oblivion we rarely notice the

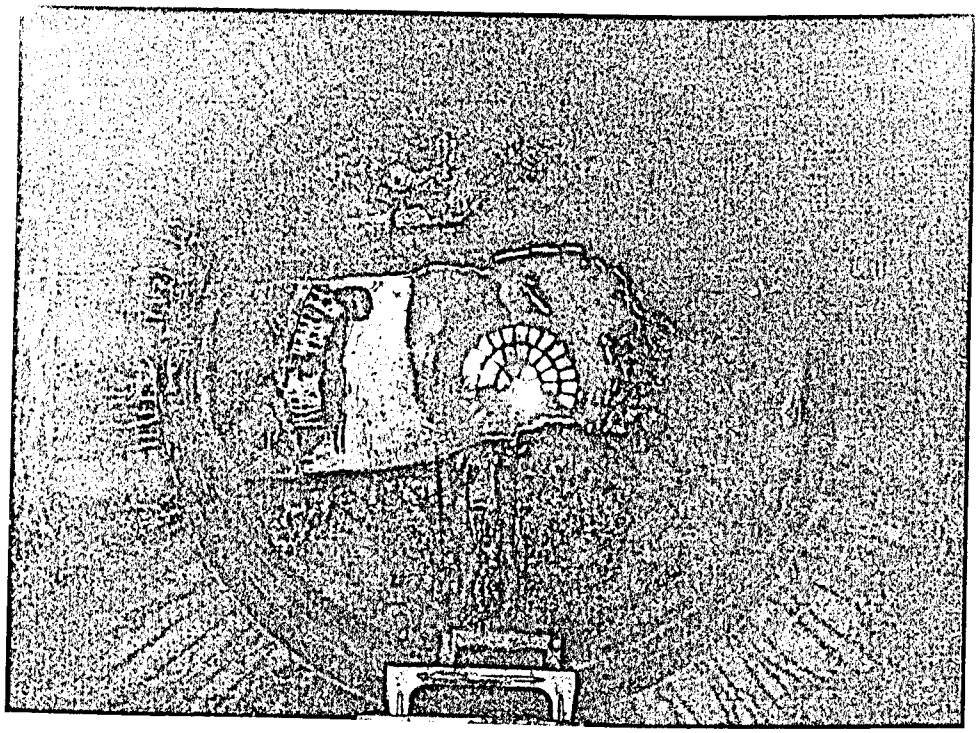


FIGURE 2.2 View of a storm drain (and composer) through a grating near the Mississippi River in St. Paul, Minnesota.

harmonic underpinning of our modern life. Basing outdoor music on this 60-cycle hum, then, might modulate in and out of this background din. Indeed, the highest compliment would be if an audience member left my event and noticed the omnipresent drone as never before; my work would have served to sharpen their senses just as John Cage was told when people left his performances they heard the traffic and birds more clearly on their way home.

A square wave 60Hz tone has many harmonics. My piece was composed on a contraption built to combine those harmonic ratios with rhythmic ones. In 1930, Henry Cowell asked Leon Theremin to design and build an experimental instrument to demonstrate his theory of relating rhythmic and harmonic proportion (the higher up the overtone series you go the faster the rhythmic repetitions in more and smaller-number ratios). He called it the Rhythmicon, and presented it on the same San Francisco concert as quarter-tone music by Mildred Couper and just intonation speech music by Harry Partch. The mechanics (rotating discs with holes) left something to be desired and it took decades before an online version by Nick Didkovsky realized the potential to any musical degree. My resulting work has been described as "suggesting what might happen if college students dropped thousands of plastic balls from the ceiling of a marble palace," though, for the record, I know of no such well disciplined students.

The ice on the Mississippi thawed late that spring, and floods spilled over the riverbanks, blocking the storm drains to a certain height in the surrounding area. Tests of my playback system were negative. Sound introduced into one manhole was not heard emanating from any other. The premiere event was only a month away for the Northern Spark Festival and 20,000 people were due to descend. Preparations continued, however, encasing speakers in nylon mesh on a long rope, and formally requesting the solid drain covers (some of them welded shut since 9/11) all be replaced with open style gratings. The day came. City workers showed up with the right tongs and attitude so the covers could be lifted and the speakers lowered twenty feet. I connected the audio loop. Walking across the park to the next outlet this time I finally heard the predicted sound, transmitted underground, but sounding hollow, crisp, and clear. Each grating now carried my music, but colored by buried concrete tubes and giving a sense of distance as the higher frequencies rolled off; something that would be hard to emulate with digital reverb. The apparently solid earth now encased the sounds and passed them hundreds of yards through its arteries, invisible yet permeating; notably different at each opening. It was not a pipe organ that J.S. Bach would have recognized, but the concept of pressure waves, filter tubes, and resonant cavities still mesh in my mind.

I like to watch the spontaneous choreography of public listening. Joggers and amblers, kids and dogs turned their heads and stopped and looked; around, up, and down. Changing course and exploring, pausing as if to sniff a new fragrance. Finding new

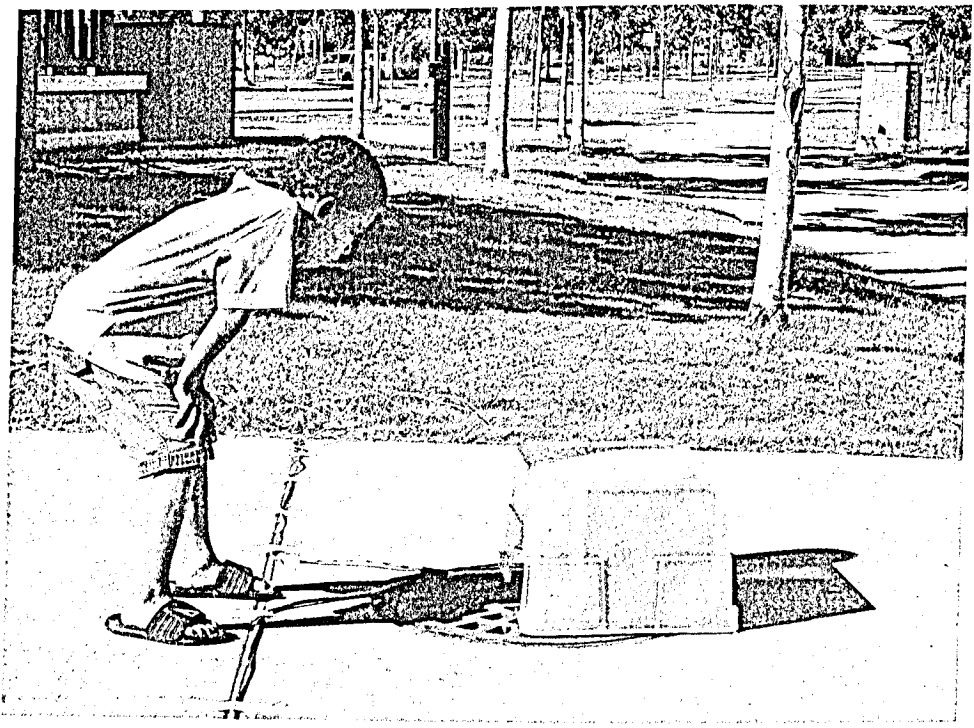


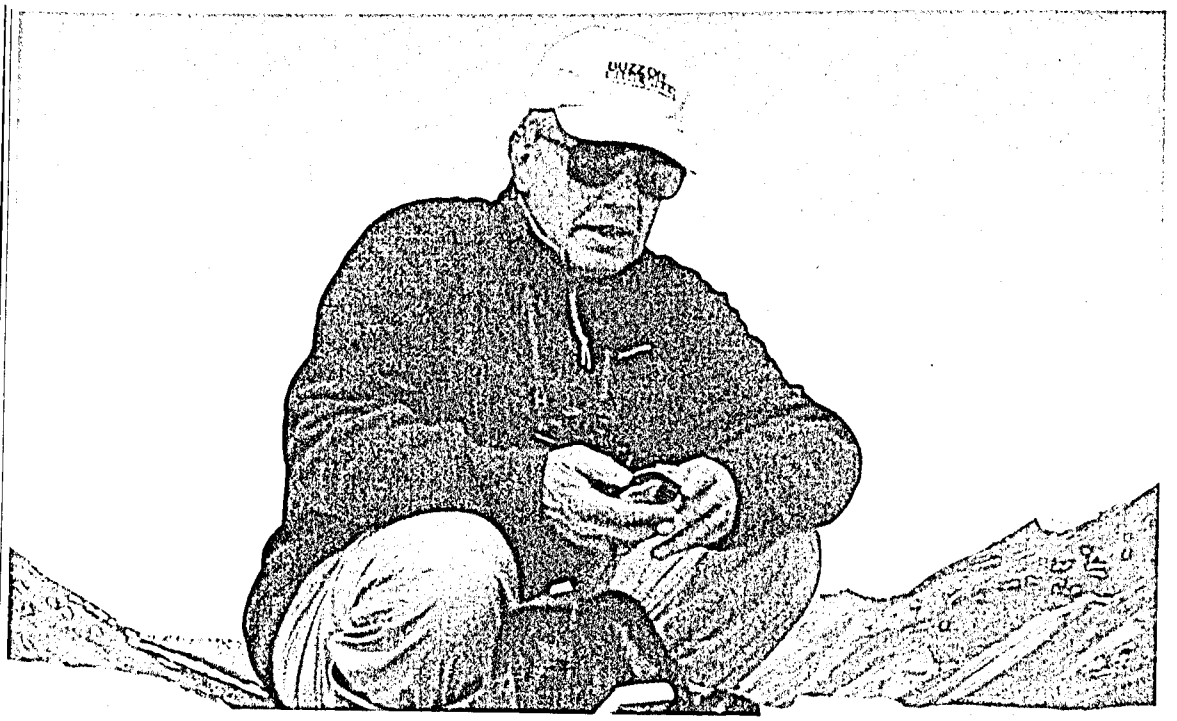
FIGURE 2.3 A local helper observes a test of the audio system prior to it being lowered beneath the manhole covers near the Mississippi River in St. Paul, Minnesota.

hotspots and lingering; taking cues from one another, becoming unwitting performers. The space seemed to affect passers-by with an invisible haptic network, a web of resonant forces that energized people's behaviors and movements through the area. It was as though they were reconsidering their own familiar trip to the park for the first time, turning a casual afternoon into a psychogeographical voyage.

People are not used to invisible public art. By nature it is to be stumbled upon. Max Neuhaus's droning sounds from beneath a pedestrian crossing in Times Square in the 70s set the stage for such interventions using hidden street architecture. The sound characteristics and their intervention into urban life, their site-specificity, are inseparable from their unique location. Indeed, finding other locations around St. Paul for a permanent Sewer Pipe Organ installation proved impossible because of the constraints of not wanting to annoy neighbors late at night, suitable drainage networks, and waterproofing and securing the playback equipment.

Reactions in the months and years since the premiere have been all the more gratifying because of the work's anonymity. It seems to have entered local lore. I have been at neighborhood development meetings where the work was referenced as a memorable moment in city life, without anyone knowing who made it. In part because of the limited access to hearing the work in its intended context, in 2014 I released it on a CD, *Music of*

Shadows, renaming the movements *Dry Spell* and *Still Points*, and barely mentioning their murky origins. The music now exists wherever and however people listen, but animated by their idea of what it might sound like through a sewer. Sometimes an installation inside the imagination is more convenient than the real thing. Sometimes the Vikings and the fog are all in your head.



Bernie Krause has traveled the world since 1968, recording and archiving the sounds of creatures and environments large and small. Working at the research sites of Jane Goodall (Gombe, Tanzania), Biruté Galdikas (Camp Leakey, Borneo), and Dian Fossey (Karisoke, Rwanda), he identified the concept of *biophony* based on the relationships of individual creatures to the total biological soundscape as each establishes frequency and/or temporal bandwidth within a given habitat. His contributions helped establish a new scientific discipline: soundscape ecology. Krause, regarded as one of the most important and influential figures in environmental sound art, has produced over fifty natural soundscape CDs in addition to the design of interactive, nonrepetitive environmental sound sculptures for public spaces throughout the world. Krause, who holds a PhD in Creative Arts with an internship in Bioacoustics, was a key figure in implementing natural soundscapes as a resource for the U.S. National Park Service.

3

Biophonic Sound Sculptures in Public Spaces

Nature is beautiful, when it imitates art
LUC FERRY, *The New Ecological Order*

I was drawn to the concept of sound sculptures because, as a bioacoustician and sound designer, I longed to find ways to express the consequences of what I was hearing and recording in the natural world by converting those outdoor encounters into media that would both capture and articulate the experiences into transformative and dramatic performance pieces.

The concept of sound transmission and acoustic sculptures is not a new one. It was first expressed almost four centuries ago when Sir Francis Bacon speculated in the *New Atlantis*:

> We have also sound-houses, where we practice and demonstrate all sounds, and their generations. We have harmonies which you have not, of quarter-sounds, and lesser slides of sounds. Divers instruments of music likewise to you unknown, some sweeter than any you have: together with bells and rings that are dainty and sweet. We represent small sounds as great and deep; we make divers tremblings and warblings of sounds, which in their original are entire. We represent and imitate all articulate sounds and letters, and the voices and notes of beasts and birds in forms like sound sculpture. We have certain helps which set to the ear do further the hearing greatly. We have also divers strange and artificial echoes, reflecting the voice many times, and as it were tossing it: and some that give back the voice louder than it came; some shriller, and some deeper; yea, some rendering the voice differing in the letters or articulate sound from that they receive. We have also means to convey sounds in trunks and pipes, in strange lines and distances.

From my perspective, one more informed by sound than sight since from early childhood my vision has not been terrific, the world has been primarily informed through what I hear. As an artist, I have always been intrigued by the quest for new ways to interpret and present sound. The course of my life has taken a number of related paths: First, as a classically trained musician, proficient with many stringed instruments and composition; then as an electronic musician having introduced the synthesizer to pop music and film in the 60s and 70s (with my late music partner, Paul Beaver); and more recently—since 1968 with parallel careers—as a bioacoustician dedicated to the recording of wildlife sounds—specifically, whole soundscapes.

During the course of these many journeys, I have come to realize that sound sculptures are one of the most important emerging forms left to explore in the realm of fine art. In part, that's because so much emphasis has been historically placed on the visual. But sound artists, even late in the game, are discovering elegant ways to transform what we're finding in the natural and cultural worlds into media that preserve and convey some of the acoustic magic to be found there. Recently identified as a branch of a new academic discipline I helped shape called Soundscape Ecology, the domain of the wild natural brings together some of the latest field and media delivery technologies augmented by cutting edge production techniques. Through those advances, many of us are inspired to create three-dimensional sonic environments thematically based on a vast range of acoustic phenomena—ones that embody many diverse themes. Through the lens of controlled sound, a major goal of the sound sculptor is to alter static spaces into three-dimensional theatrical environments that define objects, highlight sources, and through the manipulation and convergence of multiple acoustic elements express whole orchestrations in space and time.

From the moment I first ventured into the natural world with a stereo recorder in the Fall of 1968, my focus has been primarily the replication of natural soundscapes as sound sculptures that recreate, as close as possible, an illusion of the original sources and to generate a sense of place. I set out to repurpose these recordings to be featured in spaces similar to the ways in which traditional artists produce their wares in any "hard" form (like clay, wood, metal, ceramic, etc.). The results, when realized to the fullest extent of the medium, are three-dimensional soundscape performances consisting of various combinations of *biophony* (the sounds produced by non-human organisms in a given habitat), *geophony* (natural acoustic effects of wind, rain, water, and movement of the earth), and *anthropophony* (human-generated sounds some of which are controlled, like music, theatre and language, while the vast majority of them are chaotic and/or incoherent—sometimes referred to as noise). Inherent in the pieces are signatures of a place, impressions of time, feelings of light and dark, movement, negative and positive space, kinetics, dynamic expression, form, tension and release, and content, intended to fill interior spaces of any size.

In the late 1970s, when I was still considering how to generate these performance models, I searched out a wide range of museums and galleries to see how sound

installations were being implemented in those venues. With few exceptions, the design models were based on the idea of affixing a few speakers to a wall and transmitting sound, any sound, through them as either push-a-button or continuous audio loops. There was little thought given to quality of either the original recording or the playback system. There was no thought given to whether the space, itself, was designed to transmit sound with the requisite acoustic architecture. Nor was any consideration given to what the visitor would likely take away from the experience.

That limited scenario began to change for me when, after earning my PhD in 1981, I was commissioned by the California Academy of Sciences to travel to Kenya on a soundscape recording expedition. The design objectives were to help transform an African waterhole diorama by removing the glass partition and bringing the exhibit out into the hall so visitors weren't separated from it. My particular mission specified the recording of enough day-night field ambiences so they could be transformed into an acoustic program designed with a sync track that would simultaneously control lighting—bright to represent daytime, and blue-black to signify evening and night. Furthermore, the plan was to have the sounds of taxidermied birds coming from the perspective of the trees where they were mounted in the branches 10 feet above the ground, and with the sound of ground-based mammals emanating from that angle. Because, at the time, we were still recording and playing back sound with analog tape media, we mixed the performances to a 4-track playback deck with three of the tracks dedicated to sound—one dedicated to upper stories of the exhibit and two tracks devoted to the stereo ambience and ground level critters. The sync'd fourth track was earmarked for the control signals triggering changes in the lighting as the soundscapes sequenced through the diurnal biophonies. This looped 15 minute program was fortunately the only acoustic presentation in that area of the museum so it had no interference from other intrusive noises. Although the space was fairly reverberant, I mixed the ambiences with relatively low density so that the program would not sound muddled for visitors. Still, from my earlier experiences with sound installations by others as described above, it was surprising for me to see that visitors often remained at the exhibit, seemingly transfixed by the captivating balance between all of the visual and acoustic components and the relative success of the illusion. The result inspired me to think of ways in which that type of performance could be improved for everyone. The answer would come six years later, in 1989, with the advent of digital technologies and the possibilities unleashed by all of the evolving delivery software.

The performance protocol I designed for natural sound installations was inspired by the way I experienced the unfolding of wild soundscapes in the real world of terrestrial landscapes. Depending on the location and season, biophonies from temperate zones in the spring of the year typically peak at dawn—often referred to as the dawn chorus—with secondary moments of density and diversity just after sunrise and at dusk. In equatorial tropical forests, because day and night are of equal length, that peak is reached at the same time each day of the year—perhaps with slight shifts in both density and diversity

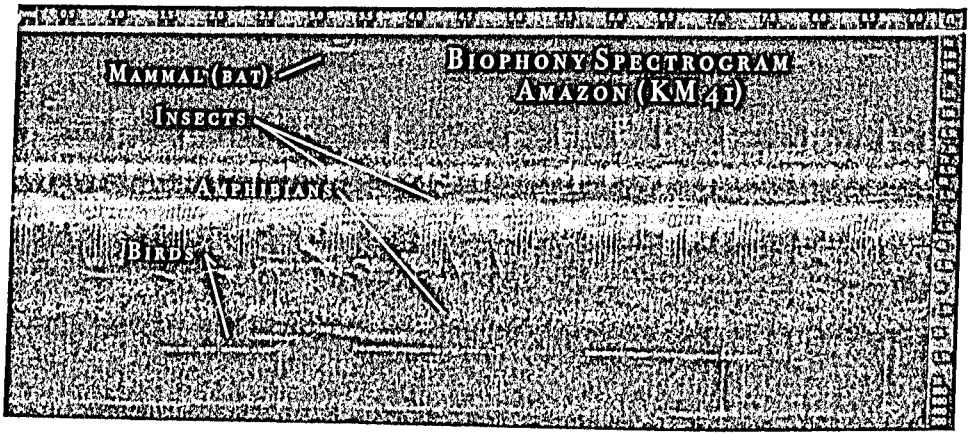


FIGURE 3.1 Spectrogram of a 10-second biophonic example of dawn chorus recording made by B. Krause at KM 41, a research camp in the Amazon Basin located just north of Manaus. Shown here is an illustration of species partitioning that occurs when a habitat is in a healthy state.

of species as the seasons progress. Nevertheless, this same narrative is expressed in every day-night cycle to various degrees and seasons in most habitats across the planet.

At the same time I was also aware that while the content and context are maintained within a certain dynamic range in wild places, every subsequent performance was slightly different; natural world acoustics are always adjusting, testing for optimum transmission and reception of signals. Therefore, while the robin might sing from the tree to the left of the spatial perspective today, it (and/or many others) might sing from the center or right side tomorrow. Successful expression, a condition of survival, is always evolving and being fine-tuned. But how could I convey a realistic sense of place and moment through sound with the inadequate audio delivery systems I was finding everywhere? The answer was to invent one.

The proprietary system I created to deliver natural soundscape performances in the late 1980s was based on the relative implementation of three components: (1) High quality original MS (Mid-Side) field recordings that afforded us the widest possible range of mixing options, (2) very robust delivery technologies and software, and (3) performance spaces specifically calibrated and designed for acoustic presentations—like a theatre or concert hall—ones where the reverberation, HVAC, and extraneous anthropophony would be consciously mitigated.

Using technologies and software that was developed and implemented with the help of professional audio colleagues in the San Francisco Bay Area, I was finally able to mix segments of the soundscapes to play non-repetitively. To accomplish that effect, we first reduced the audio components of the mix to a number of related ambient tracks designed to follow certain protocols like the timeline of an entire day/night cycle. Then we added related species-specific tracks that would be mixed automatically and constantly into the ambient clips at appropriate times and with calculated spatial relationships. Sometimes the individual species would appear near-field (close-up). Sometimes they would be

mid-field (not quite so near). Sometimes they would be heard in the background coming from the far left or far right in the spatial perspective. At other times, they would travel across the stereo spectrum in pre-determined directions, for example, a flock of birds flying overhead. In fact, the programs never repeat in one's lifetime. With this type of production and technology, the visitor experiences continuity, mutability and the impression of motion at the same instant, with performances always refreshed and new, unlike forms of stationary and conformed art pieces.

Each iteration of the program is likewise interactive. As the visitor walks through different zones, he/she will trigger certain events to occur at random. Perhaps leaves might rustle mysteriously on the ground; birds will be flushed into flight from nearby areas; as the visitor approaches a zone where frogs are vocalizing, the amphibians would stop until the visitor moves on before chorusing, again. Audio levels are controlled by crowd density so that they're never too loud or too soft. And, finally, there are a number of visual support components to further engage and inform visitors like streaming spectrograms—graphic illustrations of sound—that convey, in real time, the cohesive structure of healthy habitat biophonies when compared to those that have become stressed, endangered, or altogether compromised by human endeavor. Spectrograms of viable biomes also show how sound is organized—the proto-arrangement of rhythm, texture, melody and form that humans mimicked and ultimately transformed into musical expression. Through frequency and temporal partitioning of species, also evident in spectrograms, the relative viability of a habitat is also expressed. Not incidentally, the graphic images derived from the soundscapes generate compelling works of graphic art in their own right. Alternatively, or in addition, real time touch screens display the identification of creatures featured in the sound sculptures with relevant information pertaining to habitat distribution, migration routes (if applicable), and other notable data.

Sound sculptures can also define space and structural elements of the non-biological world. I once designed an installation that traced the form of a large, complex metal figure. As visitors entered a large darkened geodesic dome, they would stand at the base of a traditional sculpture comprised of geometric shapes like long arching tines, circles, squares, and triangular contours. The figure, some 20 feet (6m) tall, would be acoustically recorded by a sound designer who would tap the different shapes of the piece in relation to different positions from the floor thus recording acoustic samples of each segment's resonant signature from many perspectives. The dome, aside from containing the metallic shape, featured 120 strategically placed and calibrated speakers, each one individually controlled from a computer and separate amplifier channels. As part of the process, the sound sculptor would then transform the different samples into a sonic representation of the metal piece so that the visitor would ultimately experience all of its elaborate permutations by ear long before the lights brightened to display the piece visually.

As a sound designer, artist, and wildlife recordist, whether recording in the field or deciding in the lab which sounds more coherently represent a sense of time and place, I am always conscious of the human choices being made and how every one affects the

outcome of our craft. Each step in the process consists of a type of edit that will influence the result. They include the selection of the recorder and mic systems, the input settings on the recorder, selected habitat, mic placement, the moment that "record" and "stop" buttons are activated, the various post-recording media transformations, and final playback system(s). Even if I technically alter no part of the raw recorded sequence, because of the complex technical interface between what occurs sonically in the wild and the scant abstractions captured in a recorded medium, all we're left with is a series of edits (decisions), a partial impression and an illusion. It's what Walter Murch, the Academy Award film sound designer who worked with Francis Ford Coppola, calls "the shadow sense." As with any medium, the best designers are able to put together all the parts and realize the art of their craft in ways more numinous than others.

The art and craft of recording and reproduction was once addressed with a certain elegance and force by John Cage. The Master had views on many issues regarding sound, music, and our acoustic world. For instance, his take on natural sound recording and reproduction: In 1989, at a soundscape conference hosted by Skywalker Sound (LucasFilm), Cage was asked for his impressions of those creating "nature" sound albums and installations who claimed to be "purists," meaning they assert that they don't edit. Cage thought for a moment, and then responded tersely and rather disparagingly, "Found art," he sniffed. "That's because all true artists know that germane to their respective crafts is transformation: the inspired conversion of sound or image from one medium to another, or ideas from mind to page—ultimate expressions far more resounding than the sources from which they spring. It is through the process of insurgency that art in any medium obliges insight into the numinous and improbable. Transformation is the key to life and [its expression through] art, the real mystery of creative nature. Attempts to replicate or capture aspects of the natural world without amendment speak clearly to a vision of paralysis and death."

And finally, the natural history designers for public spaces are now coming to terms with the fact that biophonic sound sculptures represent the true voice of the natural world. Without that voice, the design is mute. About 15 years ago, I was asked to make a presentation to a wildlife museum in the American West. Well-funded and located in one of the truly spectacular areas of the country, the venue was mostly filled with representative art and sculpture that was rather common and safe. What struck me most was that the galleries were dead silent, never mind the graphic representations of signature critters—whales, wolves and eagles—that were abundantly represented on the walls. The venue had a large auditorium, a space rarely used, but with an excellent sound system, stage, screen and projector. It, too, was silent except for an occasional lecture or film festival. In my proposal I suggested installing a series of sound sculptures augmenting the American West themes of the museum. They would be mounted in the theatre space so that visitors would have an opportunity to hear aspects of what was being represented visually. After reading the proposal, the museum director at the time responded that she was particularly insulted at my audacity to combine the term "sound" with "sculpture"

and therefore rejected the plan out of hand. Of course, that attitude has changed over time and the resistance to these concepts has diminished somewhat. In Europe, for example, the idea of a sound sculpture is pro-actively embraced as with the exhibit I recently installed in London at the Horniman Museum in 2014 and in another to be installed at Fondation Cartier pour l'art contemporain in December of 2015.

Through the new discipline of Soundscape Ecology, the art of sound and sound sculpture plays a major role conveying the import of how we experience the voice of the wild as an integral expression of the living landscape. It is a subject that is expanding along with our increased understanding of other natural world phenomena. I am especially encouraged to see the intersection between art and science where these ideas support each other in ways far greater than the sum of their parts. As Robin Wall Kimmerer wrote in her recent book, *Braiding Sweetgrass,* "Science is rigorous in separating the observer from the observed, and the observed from the observer." But, she continues, it's far "more important to seek the threads that connect the world, to join instead of divide." Sound sculpture, then, particularly that representing the natural world, is a significant link we cannot afford to dismiss.

John Bullitt turned to art after an early career in geophysics when he could no longer find satisfactory answers to his questions about waves, motion, change, and time using the language of science. In his creative studio work he explores the inaudible, intangible, and invisible fields of energy that permeate our outer and inner worlds and underlie human experience. Bullitt believes the Earth is an ideal metaphor for the human unconscious, and his perspective on the Earth's seismic activity causes him to contemplate how we can live our lives skimming the surface of the planet, yet seldom aware of the powerful tectonic forces deep below that drive entire continents and give shape to the planet's familiar surface features. Bullitt is an artist, philosopher, and intellect extraordinaire. His work has appeared on National Public Radio (2006) and in the Portland (Maine) Museum of Art 2013 Biennial. He has a BA in physics (Grinnell College, 1980) and an MA in geophysics (University of California, Berkeley, 1982). He lives in Steuben, Maine.

5

Listening to the Earth

Earth Sound

When we think of "sound" what usually comes to mind are its myriad airborne variations: bird song, wind, speech, music, automobile traffic, and so on. Yet there is another kind of sound that surrounds us, but which we seldom hear: the sounds coming from within the solid Earth itself. At this very moment, vibrations are crisscrossing the ground beneath your feet, from earthquakes, storms, volcanoes, explosions, meteorite impacts, and a host of other events that may have occurred nearby or many thousands of miles away. Because these vibrations are so small in size, so low in pitch, and conduct so poorly through the air to our ears, we cannot hear them. But with a little technological intervention, we can. Using methods learned from an early career in seismology, I record these vibrations, translate them into audible sound, and create multi-channel sound installations and other opportunities to—quite literally—listen to planet Earth.

Why listen to the Earth? The answer is simple: Because it may have something important to tell us. This is especially true now, during a particularly uncomfortable transitional moment in humanity's relationship with the planet. Although the rich tapestry of the Earth's own vibrations has been the sonic backdrop to the natural world since the dawn of time, we never evolved the sensory apparatus to match the deep scales of time and space at which it operates. Who knows what subliminal effects it may have had on life on Earth? Who knows what it can teach us today?

The Earth has long been an apt metaphor for the human unconscious: we live out our lives skimming the surface, seldom aware of the powerful tectonic forces deep below that drive entire continents and give shape to the planet's familiar surface features. I believe that the time has come to lift these sounds into our collective conscious awareness. Perhaps befriending these sounds of the deep can help us become more fully conscious beings.

In releasing these subterranean sounds into the air and into human ears, I hope to provoke in the listener a series of important and potentially transformative questions:

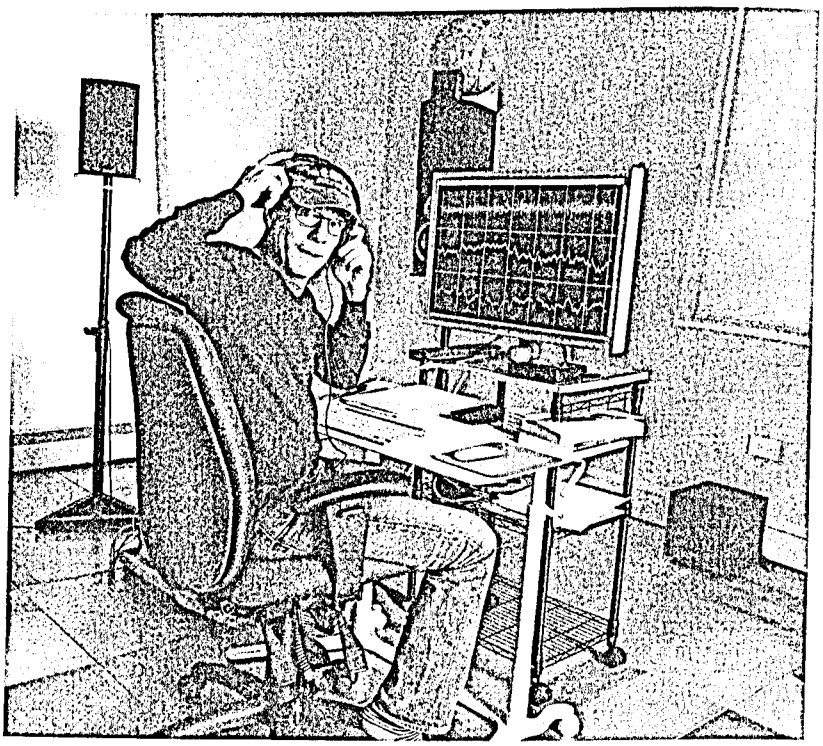


FIGURE 5.1 Bullitt in his studio, listening to live multichannel audio coming from inside the Earth.

Why can't I ordinarily hear these deep sounds? If I am normally oblivious to the Earth's own natural powers, with what else am I likewise out of touch? Are there similarly hidden forces operating within me? How does the significance of my own choices and actions compare to the enormously powerful geologic forces operating within the Earth? What is my relationship to geologic time? Will the Earth remember me? Why am I here?

Deep Earth Dome (2006–2008)

While working as a seismology researcher in the 1980's at the Massachusetts Institute of Technology, I began tinkering in my spare time with transforming into sound the wiggly lines of the earthquake seismograms that I was studying. I tried a variety of approaches, using custom software that I developed on a Macintosh computer, and eventually found that the most satisfying results came from one of the simplest kinds of "audification" of these signals: speeding up the low-frequency digital seismic recordings several hundred- or thousand-fold, and playing them back as sound. My friends and colleagues with whom

I shared audio cassettes of these early experiments were largely supportive of my efforts, if a bit baffled by my enthusiasm for these peculiar sounds.

Although I was convinced that listening to the sounds of Earth a profoundly significant act in and of itself, I was unable to use the scientific language of my budding professional career to articulate my reasons. A serendipitous meeting at MIT in 1986 with visiting Canadian artist and visionary Juan Geuer changed everything. Geuer had already been exploring many of these questions in his own geophysically informed art (*Al Asnaam* (1979) and *The Loom Drum* (1986)) and immediately understood my passion, encouraging me to use the language of art to express my ideas. It took me another twenty years to grow the confidence needed to bring them into the world.

In 2006 I rented studio space at Joy Street Studios in Somerville, Massachusetts and got to work designing a large-scale Earth sound installation. To the scientist in me, the strategy seemed clear and straightforward: take a set of digital seismic recordings made simultaneously at observatories around the world, convert them to audible sound, and play them back simultaneously through a three-dimensional array of loudspeakers. The artist in me knew that this was going to be tricky, for its success depended on simultaneously achieving several crucial non-scientific goals.

First, the sounds had to be presented in a way that was *true to the Earth*. This was not to be a musical composition or an "interpretation" of the Earth's sounds. I resolved not to add echo, reverb, or other special effects to mold the sound into anyone's conception of what the Earth "should" sound like. Second, I wanted the experience to be *convincing*. I wanted listeners easily to suspend their disbelief, to enlarge the scale of their spatial awareness, and to imagine themselves standing within the Earth's vast subterranean cathedral of sound. Third, I wanted the experience to be *significant*. I wanted listeners to quickly grasp that, yes, they were indeed listening to their home planet, and not some abstract pseudoscientific representation of the Earth. Finally, I wanted the piece to allow for the possibility of a *heartfelt* response. It had to be more than a dry didactic demonstration suitable for an Earth science class; it needed to allow the listener the space to reflect, to dream, to cry. It proved to be surprisingly tricky to manage all of these competing requirements.

The first and most crucial choice was by how much to alter the pitch of the recordings. The possibilities are practically endless, given that the Earth's natural vibrations—from the twice-daily solid-Earth tides to the highest frequency seismic waves—span an enormous range: more than 15 octaves. The highest pitches of these are some five octaves *below* the lowest notes of a piano keyboard. If the sounds are played back too slowly, the listener experiences only a dull, chest-vibrating rumble—a cinematic cliché that we might expect from a Hollywood disaster film—with no sense of the planet's extraordinary interior spaciousness. Played back too fast, strange squeaks and chirps fly across the listening space in an incomprehensible blur. It is, of course, a subjective choice. To me the sweet

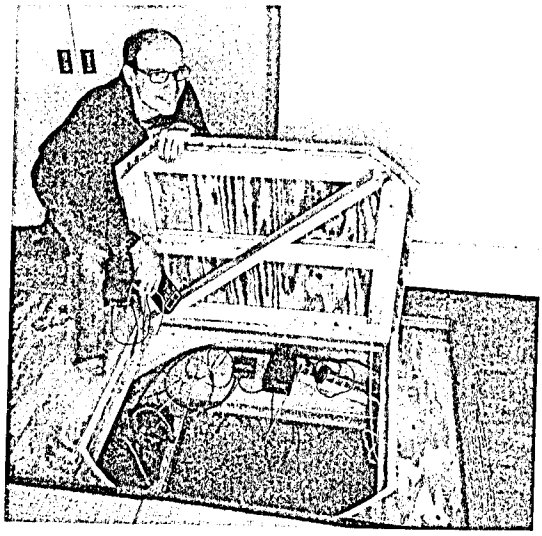


FIGURE 5.2 The seismometer is perched on an outcropping of bedrock beneath the floor of the author's residence. A hatch in the floor provides access.

spot is found by adjusting the speed so that the overall effect sounds somehow "natural": the Earth's background ambience sounds "oceanic" (fitting, given its origin beneath the world's oceans), the earthquakes sound somehow "rock-like", and the Earth's natural reverberations traverse the listening space in a clear, coherent, and "natural" way.

The result was the sound installation *Deep Earth Dome* (2006–2008), a self-funded project that ran for two years at my studio. In this installation the seismic sounds of Earth were distributed across an array of loudspeakers in an imaginary Earth-like sphere of sound (the "dome" of the piece's title). Down in this corner of the room were the sounds recorded in Australia; high up over on this side were the sounds from Scotland; over here was California. Listeners were encouraged to wander through the dimly lit room, exploring the ever-shifting textures of sounds that flowed through the space, as if they were going for a stroll within the Earth itself.

When the Earth was relatively quiet, the space was filled with the swirling sounds of the planet's ambient seismic background. Now and then an unexpected *pop* or *whoop* would occur somewhere in the room, signifying the occurrence of an earthquake from that part of the world. Occasionally the *boom* of a large earthquake would erupt from a corner of the room, then wrap itself around to fill the entire space, reverberating across the speaker array as the seismic waves repeatedly circumnavigated the planet, only to eventually fade away back into the soothing background ambience.

The Significance of Listening to the Earth

The immersive audio experience of *Deep Earth Dome* elicited a wide range of emotional responses from visitors. Many described it as a meditative experience. Some likened the

sounds to pre-natal ultrasound recordings of the womb. Young children would frequently curl up on the floor at the feet of their parents or near one of the loudspeakers to bask in these strangely familiar sounds in the dark. One five-year-old told me afterwards, "It made me feel quiet and happy." A rare few adults, however, found the unpredictability of the Earth's sounds so disturbing that they could not bear to listen for more than a minute. Some (like me) were unexpectedly moved to tears by the recognition that they were experiencing, for the first time and in a new way, the voice of their home planet.

The uniqueness and significance of these sounds seemed to catch people's imagination. After a piece about my work aired on National Public Radio, I received visits from artists, musicians, dancers, physicists, parents, and school groups; clearly there was a yearning to listen to our home. These sounds are now finding their way into the ears and imagination of listeners around the world. Composer Matthew Ferraro used them in his monumental orchestral/choral piece *Tension of Opposites*, which premiered at the Barbican in London in 2009. A number of talented dance choreographers have also worked with these sounds, creating breathtaking abstract dance performances and videos. Of particular note are Abe Abraham's video *Wind and Tree*, which premiered in New York in 2011, and San Francisco choreographer Erin Malley's *Quake*, which premiered at the 2014 Topanga (California) Film Festival.

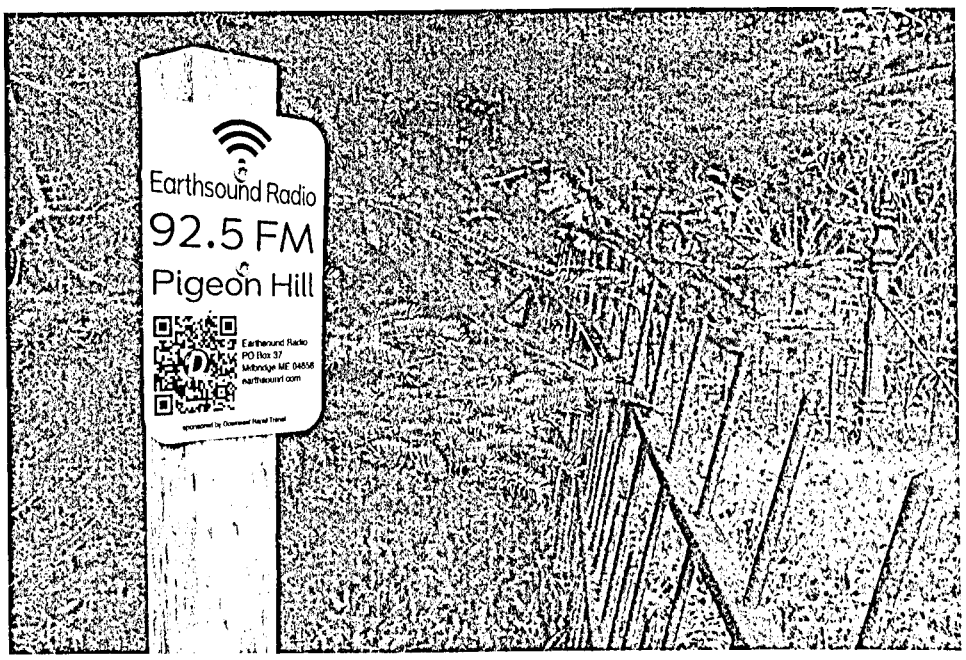


FIGURE 5.3 Visitors to a popular wooded hiking trail near the author's Maine studio are invited to tune in to the seismic sounds of the Earth.

I continue to explore ways to bring the seismic sounds of Earth into ears and consciousness. In 2014 I launched *One Week on Earth*, a five-minute podcast that presents the previous week's seismic activity, as recorded by a seismometer under my Maine studio. A few months later I launched *Earthsound Radio*, a micropower FM station that broadcasts a continuous loop of the *One Week on Earth* podcast into the sky, offering neighbors and passers-by—and, perhaps, space-travelers—the opportunity to tune in to the deep sounds of Earth.

A Farewell to Wilderness?

Listening closely to the Earth is like getting to know one's neighborhood. Over time, one begins to recognize familiar faces. With a little practice, for example, one can recognize the sound of a nor'easter traveling up the coast of North America, or distinguish between the sound of an earthquake in Alaska and one in the Solomon Islands. But every now and then an unwelcome stranger drops in. During the decades of the Cold War, these intruders streamed in by the hundreds, in the form of underground nuclear test explosions, rattling the entire planet. With that era happily (if only tentatively) behind us, we Earth listeners have enjoyed basking once again in the Earth's "natural" planetary sonic environment, free from human influence. It now seems that our relief was premature.

In 2014 I began to notice that almost every week, right here in Maine, an unfamiliar sound would intrude amidst the familiar background ambience: the sound of an earthquake in Oklahoma or Kansas—regions of North America that have historically been seismically very quiet. Why are we hearing these unusual earthquakes? Geologists and seismologists are now scrambling to find the definitive answer. But a growing body of circumstantial scientific evidence gathered from across the continent now points to the same thing: the earthquakes are caused by the injection deep underground of toxic wastewater from hydraulic fracturing ("fracking") operations.

The anthropogenic degradation of the Earth's wild soundscapes by automobiles, ships, aircraft, explosions, and all the other invasive fragments of civilization's sonic debris has been well documented by nature recordists and environmentalists. Sadly, to a long list of affected ecosystems we must now add the once-pristine sonic wilderness of the subterranean, an unforeseen casualty of the pursuit of ever more profitable sources of energy. To lose this, one of Earth's last natural refuges, our sonic cathedral of the deep, would be tragic indeed — not just for those of us who find meaning in listening to the Earth, but for all who walk upon her surface and who, consciously or not, feel her vibrations underfoot.

Happily, there is some good news. Long after we humans have vanished, man-made earthquakes will subside and the naturally lush subterranean ambience will return, thriving as it did for billions of years before we ever appeared. At least on the geological time scale, beauty will prevail. Even so, let us listen to the Earth while we still can.

Photo by Pete Woodhead

John Luther Adams, an artist of extraordinary depth, is more than a composer. Part ecologist, philosopher, explorer, naturalist, and artistic alchemist, Adams seeks to open our ears to unheard musical landscapes, the cycles of nature, the sonic signature of geographic locations, and the rhythms of the Earth. His symphonic work *Become Ocean* was awarded the 2014 Pulitzer Prize for Music and the 2015 Grammy Award for "Best Contemporary Classical Composition." Columbia University has honored Adams with the William Schuman Award "to recognize the lifetime achievement of an American composer whose works have been widely performed and generally acknowledged to be of lasting significance."

6

The Place Where You Go to Listen

An Ecosystem of Sound and Light[1]

They say that she heard things. At Naalagiagvik, "The Place Where You Go to Listen," she would sit alone in stillness. The wind across the tundra and the little waves lapping on the shore told her secrets. Birds passing overhead spoke to her in strange tongues.

Naalagiagvik (The Place Where You Go to Listen) is the Iñupiaq name for a place on Alaska's Arctic coast. Legend has it that a certain woman, sitting quietly in this place, could understand the languages of the birds and hear the unseen voices all around her.

In this spirit I conceived *The Place Where You Go to Listen* as a contemplative space for tuning our ears to the unheard resonances of the earth and sky.

This work is grounded in the geography of Interior Alaska, the sprawling region that extends from the crest of the Alaska Range to the crest of the Brooks Range, encompassing much of the Yukon River basin. The cycles of daylight and darkness in this region are extreme. In summer there is constant light. Winter nights are very long. At this high latitude the magnetosphere is especially active, and the night sky is often filled with vivid displays of aurora borealis. This is also one of the most seismically active regions on earth. The weather, too, is extreme—ranging from deep, clear cold in winter to thunderstorms and raging wildfires in summer. These extremes of light and darkness, geomagnetism, seismic activity and weather are the geophysical foundation of *The Place Where You Go to Listen.*

The architectural setting of *The Place* is a room situated just above the main entry of the Museum of the North at the University of Alaska Fairbanks. A small antechamber houses a display that introduces visitors to the work. The main chamber is approximately

1. John Luther Adams, pages 110–116 from *The Place Where You Go to Listen* ©2009 by John Luther Adams. Reprinted by permission of Wesleyan University Press.

Figure 6.1 Satellite mosaic of Alaska. (Geophysical Institute of the University of Alaska)

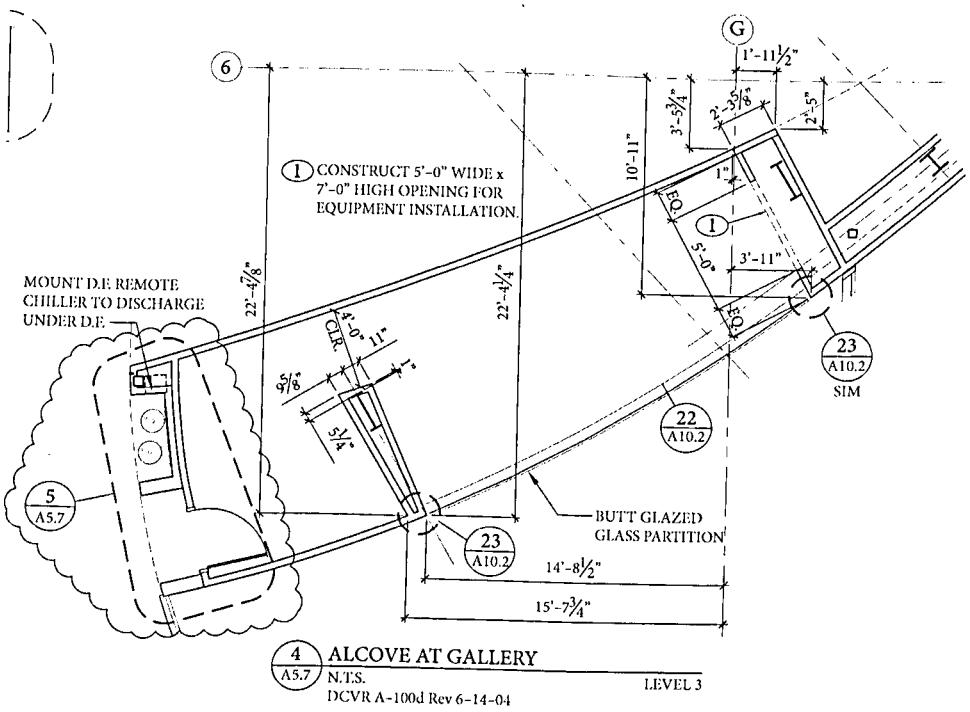


Figure 6.2 Floor plan of The Place. (University of Alaska Museum of the North)

ten feet by twenty feet. The ceiling slopes gently from fifteen feet at the northwest corner of the room to thirteen feet at the southeast. Loudspeakers are hidden in the walls and ceiling all around the space. Aside from a single bench in the center, the room is empty of objects. But it is filled with light and sound.

Mapping the Terrain

The Place Where You Go to Listen is a virtual world that resonates sympathetically with the real world. Creating this parallel world involved making maps, exploring and tuning the sonic terrain.

In *The Place*, streams of data tracing natural phenomena (seismic activity, geomagnetism, cloud cover and visibility, the movements of the sun and moon) are transformed into sound through a process that is sometimes called *sonification*. Sonification is not to be confused with *audification*, which is the direct rendering of digital data with inaudible frequencies into the audible range, using re-sampling. (An example of audification would be speeding up an hour of seismological data to play in a second.) Sonification is the process of mapping data with *some other meaning* into sound.

In a sense the data streams constitute numerical maps of the geophysical forces that animate *The Place*. Using these data maps as points of departure, I devised new maps for translating the data into sound. As I listened to the sounds produced by these aural maps, I began to explore the specific features, the detailed topology of the sounding terrain. I then revised my maps to more accurately produce the sounds I heard in my mind's ear, which, inevitably, were influenced by what I heard in the air.

This process of mapping, listening and re-mapping continued until I felt a particular sound had "the ring of truth," resonating in a convincing way with the geophysical force from which it was derived. As the voice of each sounding element emerged, it had to be integrated into the larger ecosystem of *The Place*, in a process I came to think of as "tuning the world."

The data streams that animate *The Place* contain multiple dimensions, reflecting the complexity of the natural forces they describe. So rather than assign single aspects of the data to isolated parameters of the sound (pitch, timbre, intensity, density, duration), I chose to take a more holistic approach.

Both the seismic and electromagnetic data streams include three separate components. But in the sonic cartography of *The Place*, these components are combined. All three components of the electromagnetic data (H, D and Z) are combined to produce a vector that describes the total activity of the earth's magnetic field above a specific location. The seismic data are mapped to produce strong representations of the two types of seismic waves (P waves and S waves) as measured at a specific location.

The Colors of Noise and Tone

> Nature produces noises not musical sounds.
>
> —Claude Levi-Strauss

All the sounds heard in *The Place Where You Go to Listen* are generated from synthetic noise, filtered, tuned and sculpted in a variety of ways. More specifically, the raw sonic material of *The Place* is pink noise synthesized with a random number generator.

Acousticians speak of synthetic noise in a variety of "colors," from white and pink to brown and black. These different colors have different curves of amplitude over frequency.

Just as white light contains all visible wavelengths, "white noise" contains all audible frequencies of sound in even distribution at equal amplitude. "Pink noise" is white noise in which the higher frequencies are "rolled off" (attenuated by 3 dB with each rising octave). This produces noise that we perceive as more equal in loudness throughout the range of hearing, a bit more like the sounds of wind, surf and other broadband noise in nature.

Because the sounds of *The Place* are produced in real time, and because the numbers that produce the pink noise are random, the micro-texture of the sound is always changing. This means that even the most precisely tuned sounds in the work contain minute variations of pitch and amplitude. The phase of the sounds is always random. This gives them a different quality than sounds produced by additive synthesis of tones. To my ear, they sound more alive.

In *The Place*, pink noise is filtered in a variety of ways to create the tones and timbres of the work. Each of the primary elements of the sound world is tuned differently.

- The harmonic fields associated with night and day are tuned in twelve-tone equal temperament.
- The bell sounds associated with the aurora borealis are tuned in prime-number "just" intervals.
- The drum sounds articulated by seismic activity fluctuate continuously within a limited low-frequency range.
- And the sound of the moon is a narrow band of pink noise that floats freely over a wider frequency range.

This varied approach to synthesis and tuning creates an orchestral range of timbres and harmonic colors.

"An Orchestration of Untouched Material"

Before *The Place Where You Go to Listen*, most of my music had been created with and for acoustic instruments. But all the sounds in *The Place* are produced with software on a

computer. While I was composing with these intangible instruments, Kirk Varnedoe's description of Jackson Pollock's poured paintings became a touchstone for me. I came to think of this work as "an orchestration of untouched material."

I conceived the music of *The Place* for an orchestra of voices, bells and drums. Two choirs of virtual voices create the omnipresent sonic atmosphere, following the arcs and colors of night and day. Low-frequency "drums" rumble in response to seismic data. And high -frequency "bells" ring with disturbances in the earth's magnetic field.

Like an orchestra of acoustic instruments, this new medium offered me many colors and spacious textures. But in addition to composing the music, I had to design and build all the instruments of this orchestra, as well as the physical space in which the music is heard. Yet despite the fact that I was creating a self-contained world, it soon became clear that I could not fully control everything that happens in it.

The Place allowed far less compositional determination of the specific sound events than my previous music. This music has no beginning, no middle and no end. It never repeats itself exactly. Although the instruments don't exist in the physical plane, they are (in a sense) "played" by forces of nature. So my primary work was to conceive of and map this musical world, to design the sounds, to set things in motion and then trust the forces of nature to provide the moment-to-moment music.

In theory *The Place Where You Go to Listen* could be tuned to any location on earth, each of which would have its own sounds and colors. But as I moved deeper into this work, I came to realize just how specific it is to the geography of Interior Alaska. The data streams that animate *The Place* describe natural phenomena that are especially pronounced here. This is my home. And, almost inadvertently, I found myself tuning the world so that this specific location would be the sweetest sounding spot on earth.

Photo by Cheryl E. Leonard

Cheryl E. Leonard is a composer, performer, and instrument builder whose works investigate sounds, structures, and objects from the natural world. Many of her recent works cultivate stones, wood, water, ice, sand, shells, feathers, and bones as musical instruments. Using microphones, Leonard explores the micro-aural worlds contained within her sound sources and develops compositions that highlight the unique voices they contain. Leonard has received grants from the National Science Foundation's Antarctic Artists and Writers Program, American Music Center, American Composers Forum, ASCAP, and the Eric Stokes Fund. Her commissions include works for Kronos Quartet, Illuminated Corridor, and Michael Straus. She has been awarded residencies at Djerassi, the Arctic Circle, Oberpfälzer Künstlerhaus, Villa Montalvo, and Engine 27.

7

Meltwater

January 9, 2009

It was a balmy afternoon in Antarctica. The sun was out and here in the heart of austral summer the temperature was actually above freezing. If I managed to get out of the wind I might even be willing to take off my Gore-Tex jacket and continue clambering around Amsler Island in just a thick fleece and two layers of long underwear. My field recorder balanced somewhat precariously in front of me on a lopsided granite block that protruded from chaotic glacial moraine. Next to it sat my trusty black backpack, full of essentials for a day out in the field on the Antarctic Peninsula.

I was poised at the base of a 20-foot high bluff of melting glacial ice. Once attached to the Marr Ice Piedmont, a glacier that enshrouds nearly all of neighboring Anvers Island, this amputated, marooned remnant was now in the process of withering away. A mere six years ago the land on which I stood was still thought to be a peninsula jutting off of massive Anvers Island. As the edges of the Marr rapidly retreated, Amsler was revealed to be a small, separate island. A significant channel of chilly seawater now separates the two landmasses.

The wall of ice had a texture resembling cobbly conglomerate rock, or millions of ice cubes haphazardly adhered together. Small cavities pockmarked its face and in them gravity drew the melting ice down into a multitude of drips. Water droplets landed on the remaining frozen surfaces, a myriad of shapes and sizes, softly striking these tiny resonators and intoning delicate pitches. I wanted to capture these barely-discernable sounds but the background ambiance of ocean waves and Antarctic breezes made recording with open-air microphones pointless. Instead, I decided to embed a pair of hydrophones in the wall. Using my ice ax I hollowed out two small cylindrical holes and gently placed the hydrophones inside.

With the gain on my audio recorder turned up all the way what I heard was a faint fantastical ice gamelan. Layers of cyclical drip melodies and subtly morphing rhythmic patterns intertwined with burbles, whispers, and trickles of almost-intelligible words—lost languages of air, ice, and stone. Experiences like this are what compel me to create.

A Sense of Wonder

Since 2003 I have focused on investigating sounds, structures, and materials from the natural world. From this research I develop musical works that explore and express wild realms and our human relationships to them. In many of my projects natural materials like wood, bark, leaves, feathers, shells, bones, rocks, water, sand, and ice are cultivated as musical instruments and interwoven with field recordings from remote locales. I have composed pieces based on natural phenomena, processes, and systems such as cloud formations, estuary ecosystems, animal breathing rhythms, patterns of wind on grass, water flow through falls and rapids, and the sculpting of mountains by glaciers.

One of the allures of making music out of natural materials and environmental field recordings is delving into the minutia of the very quiet. Condenser, underwater, and contact microphones enable me to explore micro-aural worlds hidden within a pinecone, iceberg, granite slab, or pool of water. I am fascinated and continually surprised by the voices these materials contain, and the beautiful intricacies of their sounds. One of the most exciting parts of developing a new work is the time I spend impersonating a mad scientist: conducting sound-producing or recording experiments and, every so often, enjoying a eureka moment as some crazy new sonority jumps out of an object or environment.

There are many ways in which items from the natural world can be played as musical instruments. Solid objects may be bowed, brushed, rubbed, tapped, blown through, or set into motion. Materials like water, sand, or mud can be dripped, drained, stirred, sifted, poured, or filtered. These techniques beget a spectrum of sounds, from clear, pitched tones to gritty, textural noises, and each specific item has its own unique voice. When amplifying natural objects, microphone choice and placement further color the resulting sounds. These are the primary factors influencing the results when recording wildlife or ambiances out in the field.

I prefer to develop compositions out of timbres, melodic fragments, and/or rhythms inherent in the original sonic materials. In most of my pieces, aside from amplification, instruments are not manipulated electronically and field recordings are shaped only through editing and layering. These sonorities are so rich and unique "as is" that they give me plenty to work with on their own.

There is much more chaos involved in composing and performing with natural materials than in working with refined traditional instruments like a piano or violin. My natural-object instruments don't always behave how I'd like them to, and in order to create a successful piece I must use these materials in ways that don't conflict with their innate characteristics. For example, a piece that asks a lumpy stone to roll in straight lines is doomed to fail. Formulating compositions that embrace some level of uncertainty, or are built on a framework of unpredictability, is challenging, but also inspiring because it

forces me to follow the music in directions I would not otherwise take; and often these are the places where the most exciting discoveries are made.

Once I find a lexicon of intriguing sounds I shape them into musical forms that embody or demonstrate a specific theme. This might be reflected in a piece's instrumentation, playing techniques, melodic and rhythmic content, organizational structures, and/or process of creation. Many of my projects touch on or are directly inspired by environmental issues like climate change, drought, soil erosion, and the health of ocean ecosystems. For me, being a spokesperson for the environment will always be secondary to my passion for pure sound and I strive foremost to create works that are sonically engaging whether or not listeners are aware of the extra-musical issues behind them. That said, I believe sound and music can be uniquely effective in forging intimate and visceral connections with audiences and actually elicit changes in thought and behavior. I try not to hit people over the head with issues I care about because I think the public is weary of being told to panic about the environment. I prefer a more subtle approach that includes sharing my personal experiences of nature within the music itself, and telling the stories behind my pieces, either live on stage or in program notes.

Most of my compositions are scored out and, in addition to being recorded, are performed live by a small ensemble. Because I write for unusual sound sources, I have developed my own system of notation in order to articulate how to play each piece. I use a combination of graphics and text instructions, sometimes with sections of traditional music notation mixed in. Each piece requires a singular approach to scoring that is specific to the instruments and sounds involved.

Over the years my musical projects have expanded more and more into interdisciplinary works. My natural-object instruments frequently evolve into elaborate musical sculptures, visual design and lighting have become a consideration in my stage set-ups and performance concepts, and physical movements and gestures often become an integral part of a concert. Several of my projects have been collaborations with visual artists and incorporate video projections.

As an avid outdoor adventurer, a passion for wilderness drives my creative process. I have been privy to some truly awe-inspiring phenomena: millions of baby frogs hopping through the underbrush in an old growth cedar forest; looking down from a mountain summit at a rainbow halo around my shadow in the mist beneath me; feeling the thunder of tons of ice calving from a glacier. Nearer to home there are smaller, local delights: gathering leaves off the sidewalk and realizing I am holding a leaf-bouquet, or looking out my window and becoming entranced by the movements of tree branches in a storm. I try to imbue my music with the sense of wonder I have at these moments, and search for ways to share my experiences. In making music with natural materials I hope to inspire others to hear the world in new ways, find music in unexpected places, and to consider the human relationship within the natural world.

FIGURE 7.1 Recording bergy bits near Anvers Island, Antarctica. (Photo by Oona Stern)

Antarctica: Music from the Ice

In 2008 I was awarded a grant from the National Science Foundation's Antarctic Artists and Writers Program to develop a series of musical compositions inspired by environments and ecosystems on the Antarctic Peninsula. This grant enabled me to spend five weeks at Palmer Research Station in January and February 2009 collecting materials for my project, *Antarctica: Music from the Ice.*

Located on Anvers Island at 64°46′ South, 64°03′ West, Palmer is the smallest of the three permanent research stations operated by the United States in Antarctica, and hosts a summer population of around 40 people. Each day I set out from the station and explored my surroundings. In fair weather I hopped in an inflatable Zodiac and worked directly on the sea, or motored out to visit one of the many small neighboring islands, each of which possessed its own unique landforms, wildlife, and sonorities. In stormy conditions I scrambled around the glacial moraine behind the station and up onto a little crevasse-free toe of the Marr Ice Piedmont. During my excursions I collected field recordings of the region's natural environments, conducted onsite musical improvisations and, with special permission, gathered a few natural objects to bring back to the United States for use as musical instruments.

Contrary to the common conception of Antarctica as a stark, barren continent, I experienced a place teeming with life, sound, and even patches of vivid color. On days

when the wind was calm, the kazooing of distant penguin colonies mixed with the snorts and howls of elephant seals, barking fur seals, squawking skuas, and squeaky terns. Meanwhile, booms and gunshots punctuated the soundscape as immense towers of ice broke off the Marr Ice Piedmont and shattered into the sea. Debris from these cataclysms disintegrated into crackling icebergs and clinking brash ice that flushed out into the open ocean. On the Marr itself, a multitude of small meltwater streams gurgled percussively, spun dulcet melodies, and babbled alien voices. Underlying all these intonations were the ever-changing, omnipresent drones of wind and waves. Using open-air condenser mics and hydrophones I tried my best to capture these astonishing sounds.

FIGURE 7.2 Recording drips and icicles in a crevasse on the Marr Ice Piedmont. (Photo by Oona Stern)

I happened upon some of the most exciting sounds of my trip when I descended inside two crevasses on the Marr Ice Piedmont. From the surface of the glacier, the crevasses didn't look like much, just ominous cracks in the snow, but inside lay ornate azure caverns adorned with thousands of icicles. Because the temperature was above freezing, dangling on a rope within a crevasse was a lot like taking a shower. First I recorded the countless water drops tumbling into the chasm, then I pulled out a superball mallet and cautiously tapped a few nearby icicles. Clear, alluring pitches rang out. Unfortunately, the icicles often fractured just as they started to resonate euphoniously, and then they fell, bouncing and shattering helter-skelter in the icy depths beneath me. I felt a little remorseful for destroying the icicles, but the mad-xylophonist cacophony they produced as they plummeted was so magnificent that it soon outweighed my guilt. I became so smitten with these sounds that I gleefully asked my friends on the surface to kick down several salvos of snow and ice from the rim of the crevasse. The discordant din that resulted had us all whooping with delight.

For instrument materials, I gathered Antarctic limpet shells, Adélie penguin bones, and an assortment of rocks. The shells I collected were the remains of numerous kelp gull meals and I was delighted to discover that they chimed in lovely treble tones. On the outskirts of Adélie penguin colonies it was easy to find the sun-bleached bones of birds that had succumbed to starvation, disease, or the vicious attacks of skuas, and I was curious to see what kinds of sounds I might make with them. The rocks I selected include a

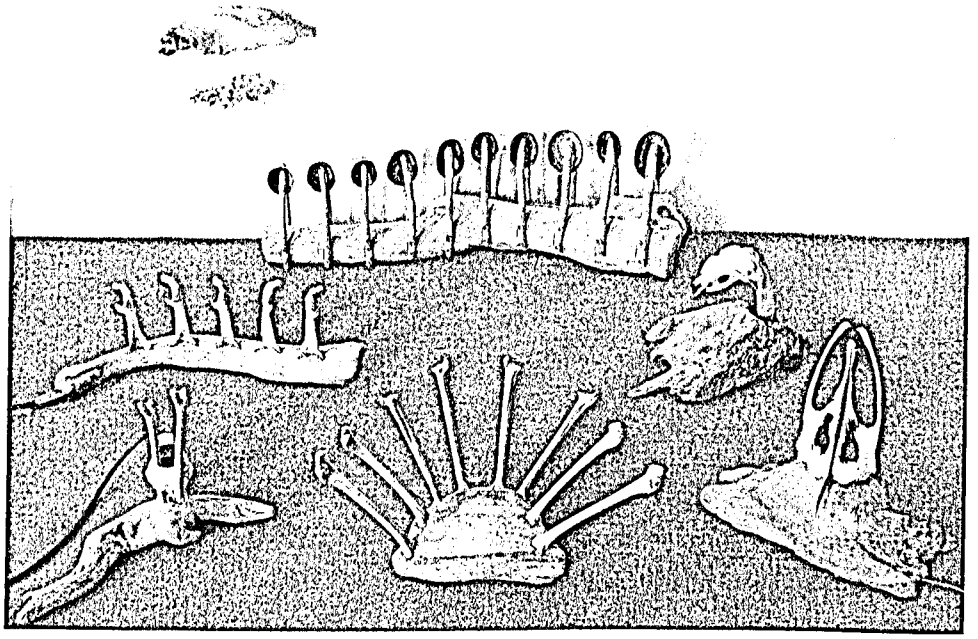


FIGURE 7.3 Antarctic musical instruments made from Adélie penguin bones, Antarctic limpet shells, and driftwood. (Photo by Cheryl E. Leonard)

handful of polished, resonant Adélie penguin nesting stones, and a set of small, pitched granite plates.

After returning home I began writing the ten musical pieces that comprise *Antarctica: Music from the Ice*. In these compositions, sounds from natural-object instruments, including the materials I brought back from Antarctica, are combined with my Palmer Station field recordings. Some of my Antarctic stones, shells, and bones are simply played "as is." Others I have crafted into one-of-a-kind sculptural instruments in which sets of bones and shells are mounted onto driftwood in arrangements that facilitate playing and are visually pleasing. Each composition has a different theme based on aspects of the Antarctic Peninsula's changing environments and ecosystems, and connects to scientific research in the region. Most of the works reflect dramatic recent shifts in the peninsula's climate: morphing storm patterns; diminishing sea ice; fluctuations in ocean currents, temperatures, and chemistry; the collapse of local Adélie penguin rookeries; and the retreat of tidewater glaciers.

Meltwater

Like most glaciers along the Western Antarctic Peninsula the Marr Ice Piedmont is contracting, its surface increasingly fractured by exposed crevasses and its periphery collapsing into the sea. Behind the station the ice has receded more than 1500 feet over the

last 50 years. The Marr inspired several of my Antarctic compositions including a piece titled *Meltwater*. A contemplation of the peninsula's shrinking tidewater glaciers and a re-imagining of their transitory, evanescent voices, *Meltwater* grew out of my experience of the ice wall gamalan on Amsler Island that warm January afternoon.

Initially I assumed I'd make the piece mainly out of my ice cliff field recordings. I anticipated adopting the process I had used to create several other Antarctic works: first ferreting out my favorite portions of the recordings and then, through precise, detailed editing, crafting them into an unfolding sonic kaleidoscope. However, upon listening back to the sounds I had captured, I realized this would be impossible. None of them adequately conveyed the depth and musicality of what I had heard, or thought I had heard, in person. Instead, what was called for was a completely different approach. I would attempt to re-create what had eluded my microphones: the ice gamalan of my imagination.

I thought it would be marvelous to use icicles live in concert, and I envisioned clusters of them suspended elegantly above the stage, dripping down into amplified scientific glassware to generate layers of drip melodies. This would be a departure from my practice of primarily using natural-objects, not man-made ones, to produce live sounds for my Antarctic compositions, but I decided that was acceptable. I also wanted to incorporate elements from my crevasse adventures: the abundance of icicles, the rainstorm inside the glacier, and the sonic cataclysms of falling ice and snow.

So first I puzzled out how to make my own icicles. I consulted sculptor friends skilled in modeling and casting, and then fashioned a set of 20-some "icicles" out of Plasticine clay. From these I made latex molds, and soon my freezer was co-opted entirely for icicle production. Into the top of each icicle I froze a loop of nylon fish line so I could hang them on hooks attached to a cord strung across the ceiling of my studio or a performance venue.

I amassed Pyrex beakers and Petri dishes of various sizes, picked out a set that formed a pleasing scale of pitches, and began experimenting with how to amplify and play them. To generate a clear, resonant ping the icicle drips needed to hit precisely on the rim of the beakers. I discovered the best way to mic this sound was to use giant rubber bands to strap a hydrophone onto the side of each beaker about an inch above the base. The beakers, which range in size from 50 milliliters to 4 liters, are also bowed, tapped, and swished, using bamboo bows, penguin leg bone mallets, and small mobiles made from driftwood, feather quills, and penguin bones. I floated the Petri dishes in clear plastic bowls full of water and wrangled them into the trajectory of drips with lightweight monofilament guidelines. A hydrophone in the bottom of the bowl captured the Petri plinks nicely. In addition to the glassware sounds, granitic stone slabs from Breaker Island, Antarctica are rubbed with smaller rocks to create drones and melodies, and icicles are clinked and clanked together.

The composition is scored for two musicians and evolves dramatically over the course of nearly twenty minutes. *Meltwater* begins with the first player walking on stage

and hanging a single icicle above a beaker. The icicle proceeds to melt at a speed dictated by the venue's air temperature and the resulting drips elicit slowly repeating pings from the first beaker. The second performer enters and positions an icicle over a floating Petrie dish producing a second pitch. One by one, over the course of five-and-a-half minutes, the players add icicles and pitches and a tapestry of shifting melodies and rhythms unfolds. Once a satisfying density of drips has been established the musicians build on top of it by bowing eerie sustained tones on the beakers, then droning on rock slabs and tapping additional small beakers, improvising melodic fragments that develop and transform into lengthy phrases. At 15:30 the first field recording emerges: the ambiance of thousands of icicles melting inside a crevasse. The pace accelerates and the music becomes increasingly frenetic as mobiles swirl against glass, and icicles clang together vigorously. Crevasse recordings of cacophonous falling snow, and then shattering icicles, join the fray, and the piece culminates in dense, thunderous glacial calving.

Meltwater also encompasses several extra-musical components. There is a ritualistic bent to the physical movements of the musicians as they hang icicles and manipulate glassware and stones with great deliberation and focus. The physical arrangement of icicles and instruments, in a straight line across the stage, is intended to be visually arresting, and lighting design plays a significant role. A tiny white LED light is installed

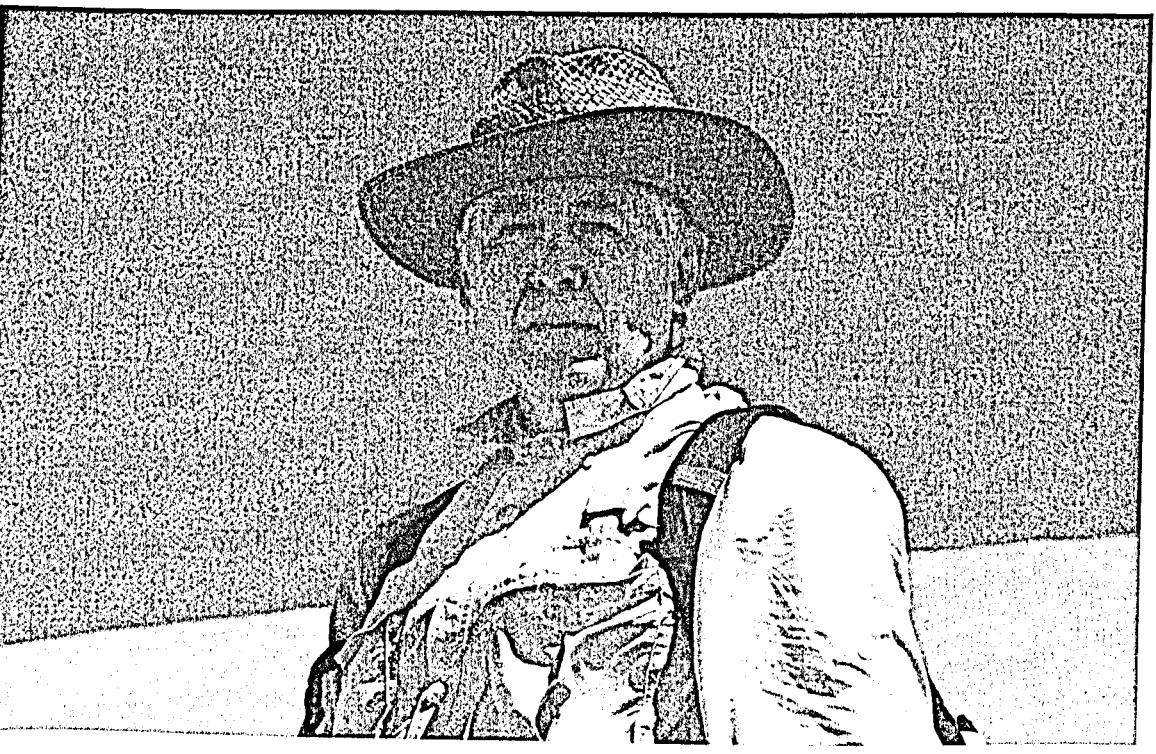
FIGURE 7.4 Inside a crevasse on the Marr Ice Piedmont. (Photo by Cheryl E. Leonard)

above each hook to shine light down into the icicles. Additional lights are placed underneath each beaker and bowl of water. Together these illuminations produce reflections, refractions, and shadows that morph hypnotically as icicles melt, Petrie dishes float, and beakers fill with drips and are played in different ways.

Compositions from *Antarctica: Music from the Ice* have been performed live in over 25 events at universities, science museums, concert halls, art galleries, private salons, radio stations, and cafes in the U.S. and internationally. Recordings of the full set of pieces will be released in 2015. Iterations of *Meltwater* have been presented four times. In 2010 an improvisatory work-in-progress version for four musicians was performed at The Lab in San Francisco. Three years later the revised, two-performer rendition premiered in a Richmond, California private salon. This was followed by an informal installation/demonstration of the work at the California Academy of Sciences. Finally a fully staged, refined version of the composition was presented in October 2013 at the Exploratorium in San Francisco. This performance was also webcast live.

Audiences have responded primarily to the beauty of witnessing the piece: the visual spectacle of glowing hanging icicles and the melodious dripping pitches. They also commented on the visceral impact of the falling icicle and calving sounds, and enjoyed the wide range of tones and textures we were able to produce from glass, ice, and stone. Phillip Greenlief, who performed *Meltwater* with me, was struck by the way that control is taken away from the musicians when working with natural-object instruments, inspiring humility and a "beginner's mind." This limited agency contrasts sharply with traditional music performance, which emphasizes the virtuosic mastery players have over their instruments. Taking this one step further, the melting icicles simply need to be allowed to be themselves and once they are hung, the musicians have no sway over them, suggesting that perhaps human control over the natural world is illusory. Phillip observed that when the icicles melt in response to the performance environment, they generate patterns and interactions that human players wouldn't produce. He also noted that by making the icicle hanging part of the performance, the audience got to watch us assemble the macroinstrument we were playing.

Overall I am quite happy with *Meltwater*. I enjoy the music and am proud of the way sound, lighting, choreography, and ritual are integrated and enhance the experience of the work. I am also pleased with the symbolism of *Meltwater* and how environmental themes are embodied in the piece. The effects of human-controlled air temperature on the melting icicles mirror anthropogenic influence on climate change, and highlight the shrinking of glaciers and polar icecaps. Collecting water in scientific glassware suggests measuring the amount of ice lost and hints at sea level rise. These themes do not overshadow the musicality of the piece but are still fundamental in its conception and realization. I believe all of these elements combine into a work that successfully conveys some of the marvels I experienced inside an Antarctic crevasse and when I first turned up the volume on my hydrophones and imagined a gamelan in a melting wall of glacial ice.



Jeff Talman has created installations with the sounds of the sun, stars, and ocean's depths and from the hum of the Earth to the sound of a single kiss. His installations are often designed to incorporate the ambient sonic background characteristic of an installation space as a compositional element of the work. Talman refers to this ambient background as *the negative space of sound.* He pioneered an approach called the *sonic reiterative resonance system* in which he amplifies the ambient resonance of the installation site and plays it back into the space. The results are unique, ear opening, and beautiful.

Born in Pennsylvania, Talman studied classical piano, music composition, and visual arts. He attended and then directed orchestras at the City College of New York and Columbia University. Installation sites include Cathedral Square–Cologne, Rothko Chapel, the MIT Media Lab, and the Bavarian Forest. Collaborators include scientists from NASA, Max-Planck-Institute, Cornell, and elsewhere. Talman's work has been supported by artist residencies internationally and New York Foundation for the Arts and Guggenheim Foundation Fellowships.

8

Hearing Curved Space

The fugitive moment is source to sonic minutiae that we ignore as they seamlessly vanish into the past. These moments engender the emergence of recollection. They are a negative space of memory upon which memory takes root. These moments are always awash in this ambient aural backdrop, a *negative sound* that constitutes a minimal sonic context of the places we inhabit.

Upon this *negative sound* we perceive and create normal or *positive sound*—conversation, music, radio and other typical daily sounds. The under-examined background sound, designated by audio engineers in the film industry as *room tone* (interior) or *exterior ambience*, otherwise continuously flows and roots us in place. As the ambient sound of a particular place, it remains vague, unobserved or obscured by louder foreground sounds.

Reiterated and self-referential sound of interior installations shifts focus to these aural backdrops, like going in with a microscope, while referencing the physical place. Installation-enhanced senses of spatial aural awareness charge the continued inevitable visual senses of space. By invoking a higher level of consciousness of background, the sonic apparentness of a space and a greater sense of self in relation to space are made available.

These site-inscribed sonic fields might be complemented by visual references to the site by way of video, light, and object-art with an intention to magnify site apparentness. The unexpected placement of loudspeakers further emphasizes the sense of place, as the site now stands in reference to installation sound location and the physical location and presentation of speakers. These site-oriented interventions serve as matrices that reinforce the reality of the site. In more than one media, they effect overlapping sensual fields that produce phenomena-charged experience in which constituent parts meld into enhanced, synthetic expressions of place and being.

Any sound that reinforces the self-sound of a site serves to activate the site. By substituting alternate sounds to activate this self-sound, the contexts of a site may be further addressed as the reality of the site is made more apparent. A path to art is opened by fusing site context and introduced sound and possible other media.

In *resonance* (2002) I activated a site with room resonance that was re-resonated live on-site by steel cylinders tuned to the resonance of the site. In *Sonalumina-13* (2004) I activated a site's room resonance by use of concurrent resonance from the site's exposed aluminum floor plates to engage supporting resonance between room and floor.

In *Mirror of the Moon* (2008) I filtered the sound of the Mediterranean Sea to activate the resonance of a museum gallery located within sight of the sea. In *Nature of the Night Sky* (2011) I worked with modeled stellar resonance for an outdoor installation in the Bavarian Forest under the starry sky. Freed of an architectural context, the pure sonic resonance that sounded far across the universe now echoed on Earth in utter calm, as ancient light from the stars illuminated the forest.

Conceptual, metaphoric, formal and expressive potentials become apparent. In rhyme with the underlining context of local environment, the installations serve as systems of phenomena that are vehicles for art. They offer composed sound works in multichannel sound necessarily experienced in relation to actual, physical site in order to gain full impact of environment, its amplification and the art that suffuses this context as its vehicle.

It is unimaginable in this era to approach an environmental sound installation and not be sensitized to concerns of the general environment itself. Installations offered note the fragility of numerous situations on a work-by-work basis. Interests touched on include those of immediate impact, such as climate change, global oceanic concerns, forest preservation, renewable energy, air quality, and avian conservation, but also approach the environment in larger dimension, as cosmic, solar and terrestrial creators of tremendous force, material, life, thought, idea, and the ethereal.

Advancing these areas has drawn my focus to another lifelong interest—science. Frequent contact with many scientific collaborators has brought an external authority to the work, as well as some of the technical means of their disciplines. Their guidance has been crucial to understanding numerous phenomena, sonic and otherwise. Enriched by their seemingly unbounded forward approaches and the clarity, thoroughness and scale of their work, an ongoing sense of exploration and adventure in the installations has followed.

Yet sound remains paramount in the installations, at times the exclusive focus. In relation to site and visual art components, the sounds exhibit abstracted gesture and moment form. They are choreographed events, linked to human rates of breath, walking and heartbeat as they embrace time and movement, as well as stasis and point location. They are all-over fields inhabiting four-dimensional space while inviting the perceiver to traverse and encounter the site-manifest environment. An installation becomes an indivisible, reflexive art object, an open-ended self-performance/experience—a time machine at the intersections of sound, object, environment and self—non-existent without the space and that revealed within its silences.

Hearing Curved Space

Midsummer Celebration, Kökar, Åland, Finland, Sunday, June 26, 2005

Remote, quiet and unmoved by the speed of the world, Kökar is a vivid, yet summer serene island on the southeastern edge of Åland, Finland, a Baltic Sea archipelago consisting of some 6,500 skerries and islands midway between Sweden and Finland at the entrance to the Gulf of Bothnia.

Invited to the Åland Archipelago Guest Artist Residency, I left New York City with no intention of putting up an installation there. I had hoped to develop concepts for new work, to make new friends, and to explore the islands, the local culture, and terrain while making numerous recordings towards possible future projects.

After working for a few days at the residency, I was approached by Salme Paldan, the residency coordinator, and asked if I would be interested in mounting a work on the island. She said that KökarKultur, their residency organization directed by Satu Kiljunen, would support the work by renting a professional sound system, though for only a short time. She hoped to coordinate the installation with Åland's annual Midsummer Celebration.

I asked her where the installation might be staged and she proposed a dream-like scenario when she said, "Ride a bicycle across the island and decide where you would like to work."

So I explored Kökar by road and bridge. I visited Otterböte, a spacious outdoor Bronze Age seal hunting station. Three thousand years later and now subsumed into the terrain, it's a beautiful meadow surrounded on three sides by high rock wall outcroppings. Though it would provide an excellent space for harboring sound, the area was swarming with mosquitoes. I continued to the intimate Church of St. Anne, an appealing space, but elevated audio projection from the white, near barrel-vaulted ceiling was not possible given the architecture.

After a day of riding, photographing and considering sites, I headed back across the island. En route to the residency I passed a 197-foot high wind turbine that sits atop one of the rocky hills of Kökar. Affectionately known as *Mika*

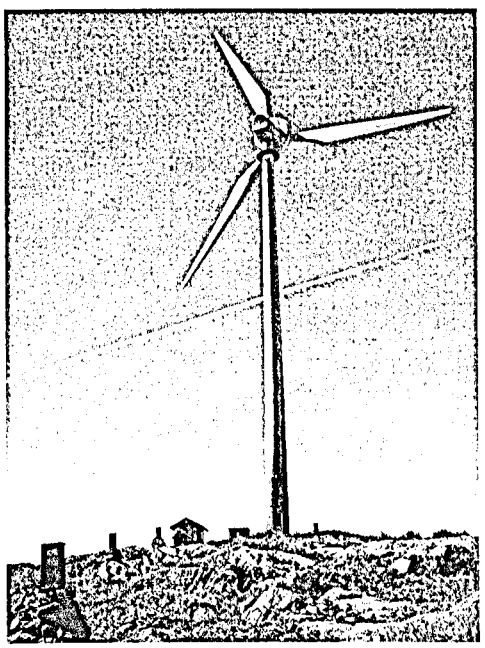


FIGURE 8.1 *Hearing Curved Space*, wind turbine *Mika* with front four sound cairns. (©2005 by Jeff Talman)

(Mike) by the island's 300 inhabitants, the turbine provides clean, renewable energy for three-quarters of the island's population.

From a distance of a half-mile or so, across the road and fields, I looked at the curve of the hill, on which *Mika* stands at the peak, and saw the circular path of the wind turbine blades far above the landscape. There was my site. There was a statement, simple, bold, and direct. Turbine sound, a minor controversy that has been virtually disproved by Canadian statistics and numerous studies, would be an asset. Certainly, for the Ålanders the turbine sound is not an issue: *Mika* is beloved.

I rode back and turned onto the pink-orange gravel road leading up to the wind turbine to make an informal survey of the site and immediate environs of the hill. Outcropping stone, pink-orange and grey granite, often lichen encrusted, is everywhere there beneath the tough junipers, grasses and other scrub. There are immense flat stretches of rock and lengthy formations of rock surfaces submerged in the hill—all battered smooth by the fierce Baltic Sea winters. At the top of the hill the road ends in front of the turbine and the nearby service sheds.

While catching my breath in the brilliant summer sunlight I scanned the panorama. The sea was visible through an inlet, the water merging in a visual oscillation with the land's dense vegetation as the view receded. Elsewhere there was forest or tall grasses, scrub and rock, and farmland, a few houses in the distance, and quiet roads. There was a great sense of isolation that's possible when viewing from a remote, elevated vantage point above the day-to-day world. But Åland is no ordinary world, it's a vibrant, magical place.

I had heard the blades far above me and the chatter of numerous birds, but more as part of an overall sense of the place. So I closed my eyes and listened carefully. I heard the spatial, wind-whip thrashing of the blades, what seemed to be a lower harmonic hum and a higher whining-whirring sound around 4kHz. These moderate turbine sounds are interesting in themselves, but because mechanical and regularized, are in extreme opposition to the lush, natural, organic sense of the island in June.

Standing directly under the wind turbine blades I greatly sensed the displacement of the blades sound, but not just across the diameter of the circle the blades traced. There's also a clear definition of verticality in the sound source as each blade whips down, across and up. I was hearing the sound of each blade through a curved space.

As I heard the curved spatial sound above me, it related to the curved hill on which I stood next to *Mika*. I decided to emphasize the curve of the hill in the installation by placing a curve of sound up, over, and back down the other side of the hill far below the turbine blades' lower arc. The installation would trace this curve over the hill. The two curves of sound would be presented in opposition to each other. Further, should winds shift, the turbine would rotate to meet the winds and so alter the relationship of the two curves of sound.

Salme immediately agreed to the site and the idea and we became very busy working towards the installation. Åland Vindenergi Andelslag, the company that owns

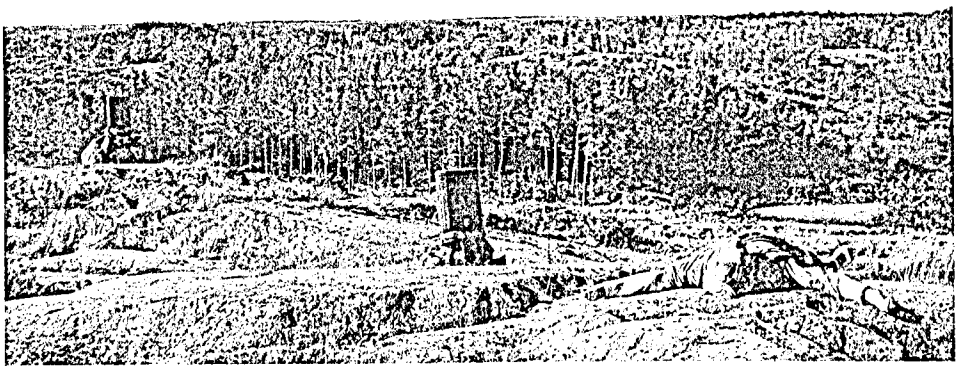


FIGURE 8.2 *Hearing Curved Space*, a listener with back two sound cairns. (©2005 by Jeff Talman)

and operates *Mika*, agreed to the installation, made the property available for the physical installation and public use and so became a co-sponsor of the work. Further, they permitted placement of the high cairn of the work on an elevated concrete platform at the base of the wind turbine, so that the apex of the lower curve's sound sources would be brought slightly higher and integrated into the actual wind turbine complex itself (the cairn is still in place to this day).

Salme and I took a three hour ferry ride to Mariehamn, the capitol of Åland, to get the key to the turbine's control center where we would store the installation's audio equipment and computer, while accessing the electrical power for the installation from *Mika*. I also bought a very small, inexpensive multi-channel sound system for studio use in making the sound program, as rental costs for the pro sound system were far too expensive for extended rental.

In the studio I analyzed the recordings made under *Mika* and noticed that the lower hum was in fact harmonized, an intact natural harmonic series in fact, though there were also non-harmonic, steady-state sounds of unrelated frequency. The higher whirring sound was indeed near 4kHz. The threshing of the blades created a very ragged, uneven, whooshy pulse, if it might be characterized that way. The sound of the blades descending, crossing and rising as they put the air in motion was reflecting from the rock hill, and so thickened. There was a lot of sound with which to work.

The wind rush of the blades permeated everything in various degree, and so gave an unpredictable and more organic sense to the entire sound. Using Csound algorithms, I extracted the "hot" frequencies from the mass of turbine sounds while opening up frequency bandwidth around those frequencies. By doing this I was able to inject those frequencies with a sense of the rushing air of the blades. The frequencies divorced from their harmonic hum and infused with band-limited blade wind sound took on an organic windy sensibility and lost their machine-related inflection. The variance in the gusting winds helped dramatically.

I created a library of sounds consisting of independent wide-band sounds clustered around specific frequencies, and harmonic combinations of these using 2 to 5 frequencies. Then I set up the small multi-channel speaker system with the speakers equidistant from each other and in line across the distance of the studio. On *Mika's* hill I measured the distance between where the installation speaker locations would be in the field, so that I could compensate for distance/timing relations in sound transfer (panning) between speakers. I then created the sound composition for the installation with these sound materials, with specific focus on panning back and forth across the speaker array, and with definite thoughts on the work's harmonic sequences, texture and other composition elements.

Sounds did not always start at an end of the array, and I did not always send the sound in the same direction across the array. At times two or more panning routines might operate simultaneously, but these were calibrated by frequency content so that they could be readily discerned. This choreography of sonic motion became a strong formal element of the finished composition and is one of the principal differences between my installation sound fields and traditional music and stereo reproduction.

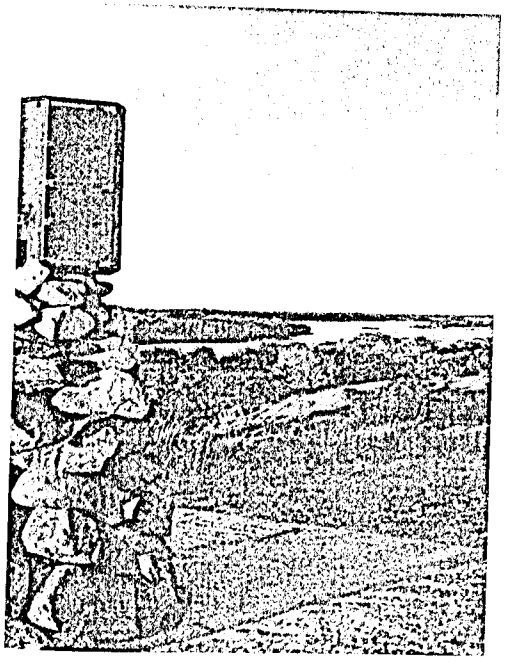


FIGURE 8.3 *Hearing Curved Space*, view from hilltop by wind turbine. (©2005 by Jeff Talman)

In placing the loudspeakers on the hill, I had immediately thought of Åland's local use of stone cairns. After soon arriving, I had gone on an island-hopping tour with Salme, the other artists and our boatsman, Lars Fagerström. As he navigated the narrow channels, inlets and rock-strewn byways I marveled at his knowledge of the waters. Lars mentioned that the many stone cairns, often painted white, atop highpoints of the skerries and islands were navigation signs that made the waters much more confidently crossed.

So to bring the installation sound up out of the land, as opposed to the aerial

sound source high above, it was perfectly appropriate to build six granite stone cairns on which to place the six speakers. Importantly, the layout of the cairns over the hill was not a simple curve that went up and over the hill. Instead, I decided to also twist the line across the hill, so that the curve up and over the hill also curved around the hill as it created a speaker array of some 950 feet in length (to put it in perspective, Mika is 197 feet high at full extension and has turbine blades with rotor diameter of 131 feet). By twisting the curve over the hill I was able to better use the terrain by opening a larger area of flat rock that overlooked a broad swath of the island, while also emphasizing the work's curve motif.

The limited quantity of stones of suitable size in the area, the backbreaking work and the increased search and longer distances to carry properly-sized stones made the building of the cairns a struggle. After a week of carrying hundreds of stones hundreds of meters, available stones at manageable distances were eliminated. I had built only four cairns and was lacking in stones, time and energy to complete the other two cairns for the exhibition of the work.

Salme contacted a local farmer, Hans Helström, who owned a backhoe and had a ready supply of stones, which he had intended to move from his own land for some time. Hans delivered two backhoe loads of stones to the installation site, enough to complete the cairns.

But after the backhoe traced its way down the hill and I began to work with the stones, I realized many of them were too large for one person to lift! Salme, somehow, then created a commando unit of island holiday visitor volunteers and the cairns were finally in place when milk truck driver Christian Helström, also a volunteer, arrived with the audio equipment that was supplied at a subsidized rate from Audio Trade, Mariehamn, which came onboard as another co-sponsor. Christian would also take the materials back to the dock after the exhibition of the work later that evening.

It was my great luck that Salme is extraordinary in aligning people, generosity and details. The audio company would not deliver to the island without an enormous fee. So she lined up volunteers to donate resources and their time to deliver the equipment—and then take the materials back the same day after the 4 hour event, including the ferrying back and forth between Mariehamn and Kökar. It was her masterpiece of coordinating the Ålander community and their generosity and teamwork that truly made the installation possible.

Thanks to Salme's contacts with local news people, the Mariehamn radio, ÅlandRadio, 91.3 FM interviewed her to provide details of the work (I was still in the field hefting more stones, then rubbing my back). An article in the Mariehamn newspaper, *Nya Åland* by Sofie Morrilund described and went into some of the background aesthetics of the installation while also discussing the work of the other resident artists—and now good friends—the Finnish couple, Paivi Takala and Vesa-Pekka Ranniko.

I designed a poster in English and Salme translated it to Swedish, then we had those printed. Salme wasted no steps, on the return run from picking up the posters we went to local shops and posted both Swedish and English language versions.

Around noon on the day of the installation Christian brought the loudspeakers and other gear to *Mika*. We moved the speakers and cables from the truck to the hilltop, then lifted a very heavy bank of amplifiers into the wind turbine control center. The race to set-up and calibrate the installation then began before Ålanders and island holiday visitors arrived at 4 p.m.

Outcome

Åland is a semi-autonomous country between countries. Though nominally under the Finnish government, the natives speak Swedish and have their own sense of identity as a people and as islanders. Åland has its own flag, anthem, parliament and customs and I experienced some of this on the day of the installation during their Celebration of Midsummer, a traditional island holiday.

I helped adorn a *midsommmarstång* (maypole) with poplar leaves, chosen because they bristle lightly in the wind with a characteristic chattering sound. The pole was raised by a captain and his team, and then women and girls sang the Åland anthem. There was more music and a lot of laughter and everyone devoured a holiday spread and enjoyed the festive, sea-wind summer evening.

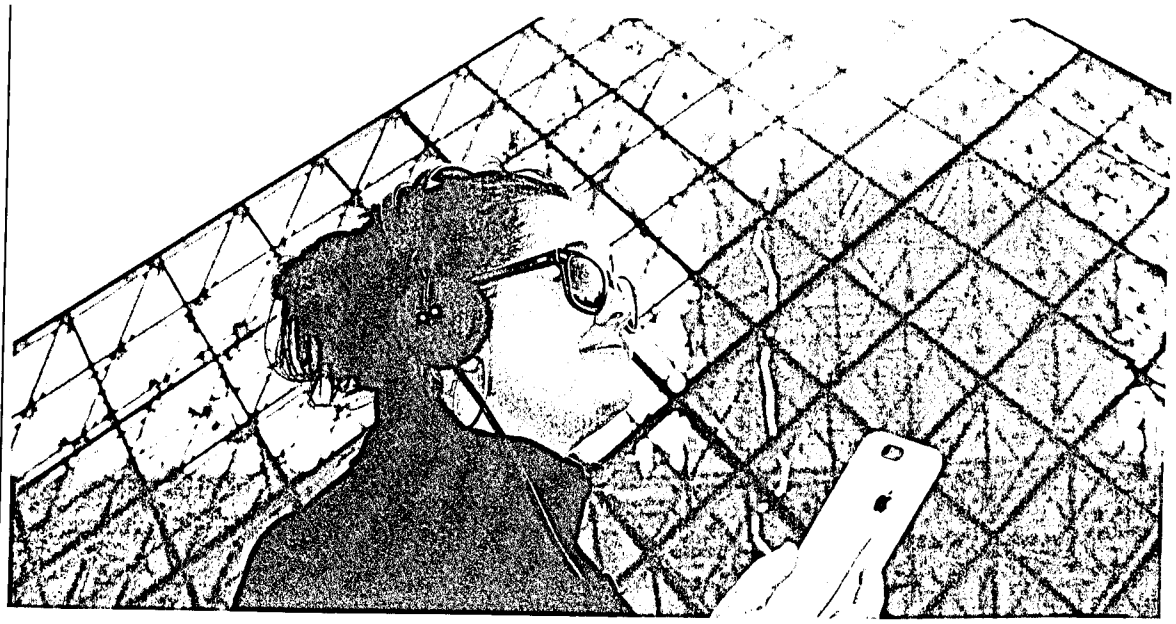
Earlier that day many of these Ålanders and their friends had visited *Hearing Curved Space*. The installation started on time and operated continuously for four hours as scheduled. There was a constant stream of visitors from the islands and elsewhere on that brilliant, gusty day. People stayed to experience the work, many for hours.

Some picnicked while listening, or sat with their friends among the rocks, or sat alone cross-legged with a sweeping island view from the hilltop, or found a solitary large flat stone outcropping and lay in the sun. The twelve-minute sound-cycle of the work was greeted by multiple-listenings as people chose to walk, stay rooted to a spot or move their location to hear the sound from a different perspective in relation to the curved sound paths. I worked at documenting the event with still and video cameras, and did not have near enough time to interact with people or celebrate the piece while it was up, but overall was able to connect with many people, some briefly on-site, and others later that evening and still others later by email.

Reactions of the installation visitors, a number of them artists, were excellent and I was congratulated for a memorable work in a memorable location. Later, as Salme and I pulled up the cables and took down the speakers and carried them up the hill to await the milkman Christian's pick-up, I thought the sound and concept were largely a success. I had "tilted" with the windmill during the longest days of the year, with extreme physical labor under the fierce Baltic Summer sun and produced a work that celebrated both midsummer light and renewable energy. I had made new friends and enjoyed the opportunity to stage ambitious work, if with shoe-string budget, in a foreign country that proved to have exceedingly generous people of good spirit—and this has stayed with me long after watching the Kökar maypole rise and hearing the women's voices singing.

Salme went on to write an article for *Arsis*, a publication of The Arts Council of Finland that discussed the installation and its "birth," and so made details of the work available to a larger Finnish audience. The article, *Kökar—Close to Nature*, was published in the third quarter of 2005.

Hearing Curved Space as a four-hour event began veering my work toward "performance" installations that I would not develop fully until 2011, when an installation was presented for fifty minutes only once a day over a run of four months. These installations, presented in a relatively short period and designed to be experienced as a single event, are now a regular mode of work for some of my installations, both exterior and interior. Bolstered by listener feedback from *Hearing Curved Space* and the "feel" of the project, I began to approach installation as an event in remote environments, and have since had works of this nature exhibited in the Bavarian Forest and along the shoreline at the tip of North America in Newfoundland, as well as event-based work presented in Rothko Chapel and Columbia University's St. Paul's Chapel. Future works of this nature that are in development engage wheat field sounds of the summer wind, mountain waves and the singing dune sounds from the deserts of the U.S. Southwest.



Leah Barclay is an award winning Australian composer, environmental sound artist, and creative producer working at the intersection of art, science, and technology. She is known for her immersive performances, installations, and large-scale community projects that explore volatile environments ranging from the central Amazon rain forest to the floor of the Australian ocean. Her work is multi-platform in nature and often involves long-term community engagement accompanied by the development of virtual platforms to explore the value of digital technology in environmental crisis. Her environmental sound art has been commissioned, performed, and exhibited to wide acclaim internationally, and she has directed and curated interdisciplinary projects across the Asia-Pacific. Barclay is the president of the Australian Forum for Acoustic Ecology and the founder and artistic director of Biosphere Soundscapes, a large-scale interdisciplinary art project connecting the soundscapes of UNESCO Biosphere Reserves across the world. She maintains an active freelance career and has collaborated with some of the world's leading arts and environmental organizations.

9

River Listening

My creative interest in rivers manifested in early environmentally engaged instrumental compositions such as *River of Mirrors* (2004), composed for chamber orchestra and inspired by elements of the Noosa Everglades in Queensland, Australia. This work used an array of extended performance techniques to imitate the natural soundscapes, and employed repetitive textures to evoke the tannin-stained, mirrored waterways of Noosa River. The following year, in 2005, I composed *Confluence*, my first major multimedia environmental work commissioned for the opening of Earth Song Exhibition, during the launch of the Queensland Great Walks. Although not inspired by a specific river, *Confluence* drew inspiration from the characteristics of water and rivers and used hydrophone recordings as compositional source material. The piece was composed for cello, live electronics, digital projections and two dancers, which created an immersive environment in a constant state of change that was controlled live. These two projects informed the development of *River Listening*, and the beginning of a large-body of work inspired by rivers over the last ten years.

As a composer, I have always been fascinated by the role of sound in generating environmental awareness and engagement. When I began working with electroacoustic music in late undergraduate studies, I realised there was great potential in composing works that could expose the state of the environment by using field recordings captured at various locations. My attraction to composing with the sounds of the environment was by no means a revolutionary concept, the ideas were explored in Luigi Russolo's manifesto *The Art of Noises* in 1913 among many other examples in the early 20th century. Today we have international organisations such as Ear to the Earth and the World Forum of Acoustic Ecology actively supporting the wide spectrum of composers working with environmental sound.

In addition to composing music, I was interested in exploring ways to expand my artistic practice and engage communities in the creative process, essentially designing frameworks that would inspire others to listen to the environment and contribute towards cultural change, albeit on a very micro level. This sparked the beginning of a PhD in composition and evolved into a complex web of projects harnessing sound to raise cultural,

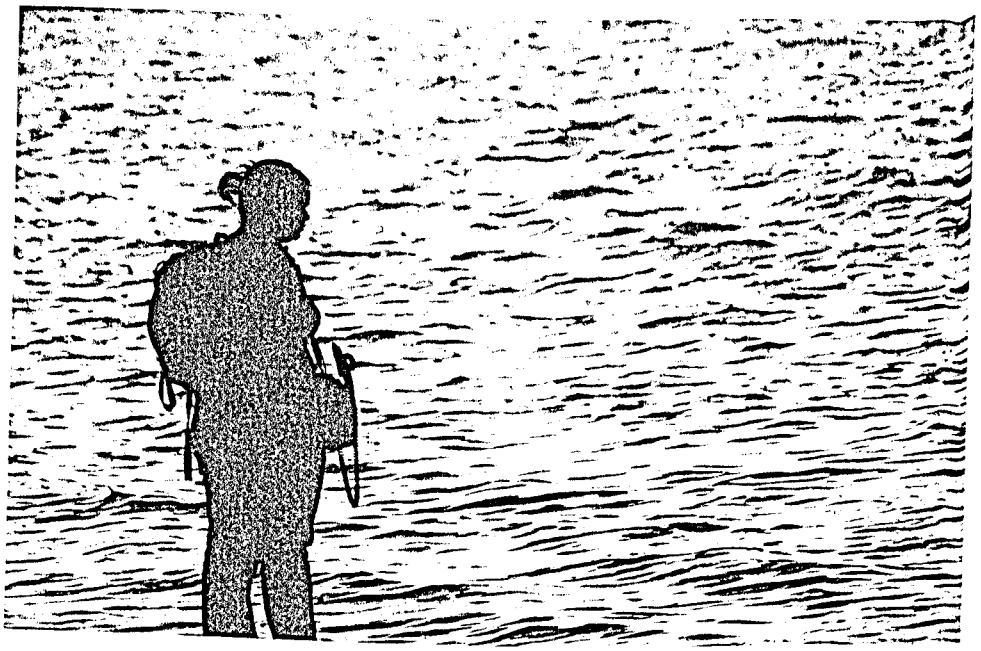


FIGURE 9.1 Leah Barclay recording Lake Cootharaba, Noosa Biosphere Reserve. (Photo by Adam Sebastian West)

social and environmental awareness. The resulting compositions were rewarding outcomes, yet it became the process itself that was most valuable. The process was not just about composing, but engaging communities in the environmental intentions of the project and inspiring others to participate in practices of listening, field recording, composition and collaborations.

These projects have serendipitously taken me across the world, from the backwaters of South India to the centre of the Amazon Rainforest. While some have been wildly ambitious, and somewhat risky, others have explored methods of simply listening to nature. The strong commonality between each venture has been composing the works in cultural immersion and my approach to collaboration, not just with other musicians, but also with communities and interdisciplinary artists. Experimenting with different methods of dissemination, increasingly distant from the familiar concert hall, also became valuable throughout this process.

This resulted in a distinctive shift in my creative practice, essentially from an internal and often isolated experience of notes on the page to an expanded awareness and social consciousness, where artistic outcomes have become milestones in broader creative visions that have engrained social purpose and intent within a community and environment. This changed my perception of what it means to be a contemporary composer, and inspired a spectrum of collaborations exploring the role of creativity in community empowerment, social activism and cultural change. The majority of projects I have developed since 2012 have been underpinned by the Sonic Ecologies framework,

a multi-platform approach to creativity developed through my PhD, where one project will most likely result in a spectrum of outcomes including live performances, installations, sound maps, publications, community engagement and more recently documentaries.

The first project where I began to see the potential of composing with this framework was *Sound Mirrors*, an interactive sound installation that responds to specific rivers across the world. During 2009 and 2010 I travelled through Australia, India, Korea, and China capturing the sound of significant rivers and their surrounding communities. This project grew out of my childhood memories of growing up on rivers across Australia and the idea of rivers as the lifeblood of communities. I was inspired by works such as Ros Bandt's *Voicing the Murray* (1996), Annea Lockwood's *A Sound Map of the Hudson River* (1982) and electroacoustic works such as David Monacchi's *Stati d'Acqua* (States of Water, 2006). As rivers across the world continue to be impacted by human activity, I wanted to build on the existing creative work in this area and reveal the sonic traits of each river in an environment that could bring attention to rivers as entities that deserve respect and conservation.

The process in the field varied from sculpting and layering sounds recorded on location to directly responding to the environment. I spent a significant amount of time field recording and creating musical sketches in each location. I often worked intuitively with these materials and attempted to capture a living aspect of culture through the sound marks of the environment. This project was produced on the road—in makeshift studios on boats, trains, riverbanks, and in hotel rooms—drawing further inspiration from the environment. The process in each location also involved extensive community engagement, a deep study of local music traditions and collaborations with various musicians.

In the instance of the Pamba river in South India, I was deeply immersed in Carnatic music, the classical music of South India. While I had studied Carnatic music for a number of years prior to this research, this was an opportunity to understand the theoretical concepts and their relationship to the culture and environment. My initial process involved daily field recording, practical lessons with Guru Subhash Kumar in Aranmula and an intensive theoretical study of the rhythmic systems of Carnatic music. I was initially quite overwhelmed by my field-recording trips on the Pamba, as my experience of recording rivers usually involved subtle hydrophone recordings of the rivers marine life or recordings of the rivers banks and surrounding wildlife. I was now faced with an apparent chaotic cacophony of constantly changing soundscapes ranging from pilgrims chanting at dawn, to fisherman yelling with rickshaw horns, to thunderous rhythmic trains.

The Pamba river has a rich history, from extraordinary legends of pilgrims to accounts of the contentious issues of pollution and environmental degradation. While the voices and stories were captivating, I was interested in a more abstract exploration of the river's voice. I began capturing moving soundscapes, initially from boats and then on the train tracks that follow the river. Naturally, recording while moving at relatively

fast paces opens up a spectrum of issues with microphone distortion, consequently, many of my recordings from boats were not appropriate for the compositions. My recordings from trains, however, were very different and I spent a large amount of time recording from the open doors between two train carriages. I fell in love with the open-air experience of the trains of India, as they tend to move slow enough along the riverbank that you can hear glimpses into the Pamba communities. These field recordings formed the foundation of *Nakshatra*, one of the first *Sound Mirrors* compositions.

Composing this project in India was intense, rewarding and, a profoundly rich learning experience. I developed a much deeper understanding of Carnatic music and created a series of compositions and collaborations that I believe revealed some elements of the Pamba river. My role as a composer on this project expanded and involved working as a producer, project manager and sound engineer. It was also a challenging place to attempt such an ambitious project, particularly in an environment where as a left-handed foreign woman working with technology, it often took some time to earn the respect of my male colleagues, particularly in the recording studio. The dynamic of functioning in such a diversity of roles in a foreign location required an intensive level of focus and I have no doubt the compositions would have been completely different had I been at home in my studio.

The *Sound Mirrors* installation has been exhibited a number of times, including the Noosa Regional Gallery in Australia, the Gallery of Modern Art in Bangalore in India, Stellenbosch University in South Africa and Siva Zona in Croatia. Eleven of the resulting compositions were released as an album, titled Transient Landscapes, which have also

FIGURE 9.2 Leah Barclay in Seoul South Korea. (Photo by Hyelim Kim)

been programmed at various conferences and festivals. I also began performing *Transient Landscapes* as a live work where I create a multi-channel mix of the river soundscapes in real-time in response to the performance location. This project has no doubt brought some attention to the soundscapes of rivers, yet unlikely made any significant contribution to the conservation of river systems. While it was a positive learning curve, I did see potential for creative projects to have a wider impact when combined with ongoing community engagement, interdisciplinary collaborations and multi-platform outcomes. *Sound Mirrors* only skimmed the surface of these ideas, but it certainly laid the foundation for most of my work that has followed.

One of the most critical outcomes of *Sound Mirrors* was realising the opportunities for using hydrophone recordings as a measure for river health. While I could never predict exactly what the river would sound like when I lowered the hydrophones into the water, the resulting recordings were always extremely revealing about the overall health of the river. This became even more apparent in my next river venture, *The DAM(N)* Project, a large-scale interdisciplinary art project that connects Australian and Indian communities around the common concern of global water security. The project is focused on community capacity building and the creation of multi-platform creative content that can be disseminated internationally. The outcomes present the lives of remote communities in the Narmada Valley of North India, which were displaced by large-scale dam development securing hydropower for Indian cities.

As with all of my creative explorations of rivers, hydrophone field recordings have become an integral element to my practice. I am always eager to hear beneath the surface of the river, as the soundscapes reveal so many qualities, including the active marine life. Unfortunately, during our first field trip I found the hydrophone recordings in the Narmada River featured very little marine interaction, similar to the stagnant and lifeless bodies of water in the Narmada villages that were virtually silent. The stagnant water now carried countless viruses and diseases, which have resulted in many people fearing the water rather than worshipping it.

While the pure hydrophone recordings provided limited source material, the soundscapes with human interaction recorded from a boat were quite compelling. The sound of people washing dishes and clothes on the riverbank, splashes as people climbed into the boat and the creaking panels of the wooden vessel as we ventured down the river. The unpredictable recordings of the hydrophone abruptly dragging along the riverbed from our moving boat are not the most pleasing auditory experiences, but they captured some of the dystopian energy of this landscape. While this is perceived as a distorted sound, and something I would probably delete in other circumstances, I was compelled to make use of this recording in the project.

The other memorable field recordings were from the Jobat dam, one of the larger dams that submerged 1216 hectares across 13 villages, allegedly displacing 595 families. The metal steps along the dam wall acted like resonators propelling my footsteps along the bridge. I was struck by the silence of the dam and the intensity of my presence amplified

FIGURE 9.3 Leah Barclay recording in the Jornada Biosphere Reserve.

in the soundscape. In situations where the hydrophone recordings provide limited source material, I compose based on my response to the landscape. *The DAM(N)* Project inspired the way I think about hydrophone recording and how listening to rivers could offer an array of possibilities for understanding aquatic biodiversity.

Many people consider rivers to be silent places, but that could not be further from the truth. Healthy river systems are filled with sound; often a symphony of snapping shrimps, frogs, fish, insects and occasional dolphins. Polluted rivers lack the natural soundscapes, but amplify the sounds of anthropogenic interference and offer a powerful reminder that the life beneath the surface has diminished.

In 2013, I wanted to expand these possibilities into a project that would have a positive impact for communities. This inspired the *River Listening* project, a venture designed to extend on the existing creative work I have done in this area to explore a process that could bring attention to rivers as ecological entities that deserve respect and conservation. *River Listening* is deeply grounded in the scientific possibilities of hydrophone recording and the role of community engagement and multi-platform presentations. The process involves not just composing (in the traditional sense of the word) but collaborating with the community, listening to each river, and, at each site, responding and adapting to other processes that may emerge.

In our current state of environmental crisis, biodiversity assessment is critical to understanding the rapid ecological changes taking place across the globe. In the last ten years, there has been a strong emergence of non-invasive monitoring involving auditory recordings of the environment. This emerging field is commonly referred to as soundscape ecology and shares many parallels with other fields, including bioacoustics and acoustic ecology. There are now a growing number of international projects embracing auditory monitoring in aquatic environments.

In 2014, I was fortunate to receive a prestigious Synapse grant from the Australia Council for the Arts and the Australia Network for Art and Technology (ANAT) to develop *River Listening* in Australia. Synapse is an initiative that supports collaborations between artists and scientists and this enabled me to develop this project in residence at the Australian Rivers Institute in collaboration with leading scientists. My lead collaborator, Dr. Simon Linke, is one of the world's leading scientists in aquatic conservation planning whose pioneering work in biomonitoring and river conservation has been used by agencies and NGOs from South East Queensland to the Congo.

Dr. Linke believes that

> ... classic techniques to sample fish are problematic; they potentially injure the study organism, they bias the outcomes, and only provide a snapshot at the time of observation rather than a continuous time series. Passive acoustic monitoring offers an attractive alternative. While some acoustic monitoring studies exist in terrestrial and marine ecosystems, little work has been done on passive acoustic monitoring of freshwater environments, despite its potential to provide significant information on the biology, ecology and population status of fish species through space and time.

Despite the rapidly growing interest in emerging auditory fields such as bioacoustics, there is yet to be standardised approaches to field recording and interpreting the data. While scientists have developed advanced software tools for species recognition, there is a growing need to consolidate the available tools and explore the value of listening to the data in new ways. There are also exciting possibilities to make this data available for a wider audience through digital technology and creative collaborations.

River Listening has evolved as a practice-led research collaboration to explore new methods for acoustically monitoring global river systems. River Listening launched on the iconic Thames in London during the 25th Anniversary of the EVA London Conference in 2014 and has developed across four Australian river systems: the Brisbane River, the Mary River, the Noosa River and the Logan River. The initial phase of the project has involved listening labs, field recording, sound maps, performances and installations to experiment with hydrophonic recording, virtual technologies and community engagement in understanding river health and aquatic biodiversity. In the first six months we have expanded the project internationally with partnerships formed across the Asia-Pacific and USA. In 2015 we are launching a customised digital platform and mobile application that will allow listeners to upload sounds and compare recordings to explore global river health through sound.

As the international interest in the emerging auditory fields of bioacoustics and acoustic ecology continues to expand, there are clear opportunities to harness virtual technologies to develop accessible community engagement around the creative and scientific possibilities of listening to the environment. *River Listening* provides a model to develop a truly interdisciplinary approach at the critical stage of creative development and it is anticipated the future results will be beneficial to national ecosystem monitoring programs. This project is a catalyst for community engagement and interdisciplinary thinking at a time when the conservation and management of aquatic ecosystems is a critical priority. *River Listening* fundamentally explores the creative possibilities of aquatic bioacoustics and the potential for new approaches in the management and conservation of global river systems. I believe projects such as *River Listening* also showcase the opportunities of environmental sound art as a tool for environmental awareness and engagement at a time when changing climates mean it is increasingly important to listen.

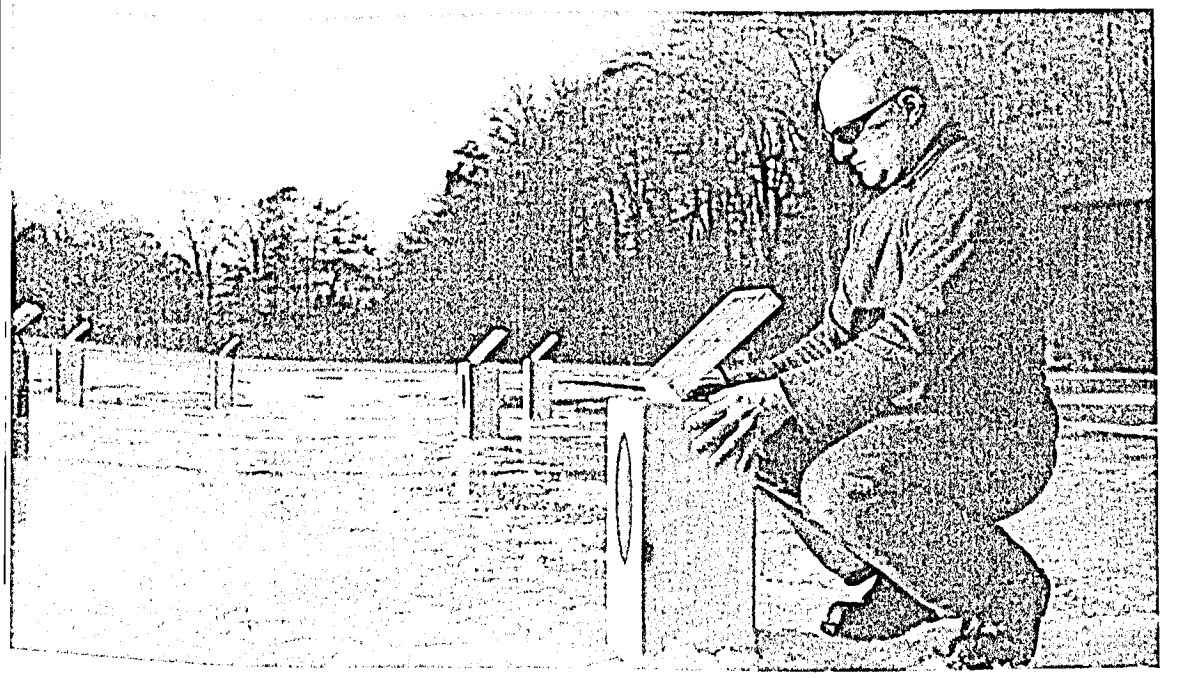


Photo by Kevin Belli

Craig Colorusso began writing his own music using a guitar and was inspired by the punk rock movement of the 1980s. By the 1990s he was in touring bands and had his own record company. After touring tirelessly throughout the United States, Colorusso found himself in one too many clubs. So he changed course and since 2000 has been exploring the intersection of sound, light, and space through sculpture. His installations consist of wood, metal, fabric, sound, and electronics. He creates sonic environments for participants to enter, freely move about, and exit. In simple terms, Colorusso creates environmental sculptures that make sound. Sometimes there is light involved. He likes things that drone, float, and glow. Colorusso currently lives in Rogers, Arkansas, with his wife, three cats, and a daughter. The daughter has red hair.

10

Sun Boxes

I started playing guitar when I was 14. To be honest, I wanted girls to like me. It was 1984, the last real Van Halen record was out, Rock Gods graced the covers of magazines like Hit Parader, Circus, Cream, and MTV actually played music videos. Truth be told, I stumbled on the real power of music shortly after I started and it had nothing to do with getting girls to like me.

Music always felt different. I was constantly surrounded by it, and it was extremely important to my life. Music has the ability to stop time. While listening to the right piece of music I can transcend time and space and be truly in the moment. Performing music heightens this experience even more. We are all bound by our flesh, but music and sound energizes something in me that is bigger than my physical existence. In 1984, music awakened the real me. From then on, the world made more sense when I had a guitar in my hands.

I always saw music as something that could literally take me places. During my teenage years, I was part of the straight edge Hardcore punk music scene in Connecticut. Kids my age were making records and touring the world. I was totally in. I wanted a place in the world of music. Soon, I was in a band, made a record, and was on the road. The experience was far greater than I had imagined, and I loved everything. I loved the volume. I loved loading gear. I loved being on stage. I loved playing in new cities. I loved everything about it, but I still craved more. While the music we were making was everything I wanted, I dreamed of expanding and combining it with other things to create a unique experience. Because music results from combining many different ideas together, I started to daydream about adding nonmusical ideas into the sonic equation.

As a performer the stage is great, it serves a purpose and serves it well. But, the stage also creates a barrier between the audience and the performer. It's a very singular experience being on stage. The crowd is herded into a room and the band blares at them. I soon realized that I wanted to create a musical experience that the audience could be a part of. I wanted to create something that would literally surround the audience and evolve as they moved through the space.

At this time, I was thinking about all the work that goes into performing the songs we composed. Though I wanted to play them well, and do them justice, I also felt limited. If every performance sounded exactly like the record, then I was starting to lose sight of it all. My mind started to wander a bit. I wanted to create something bigger.

I also began to wonder about the structure of music itself. Does there need to be a beginning and ending? Could I create something that just exists and continuously evolves? Something you could enter and exit without feeling you had missed something. As I began to imagine music as something different than songs, the world began to enlarge. I realized that what I was working towards was less like music and more like sound design and inventing.

In 2008, my longtime friend "Sexy" David Sanchez called me up and said, "YO! Make something solar. We're going to the desert." and then hung up. At that moment, I started to think about what would eventually become Sun Boxes. Soon after, I went to Rhyolite Nevada with Dave and a guy I had never met named Richard Vosseller. We had a residency at The Goldwell Open Air Museum where we made a show called "Off The Grid" using sustainable energy to create art. Since I've always been fascinated by solar energy it wasn't too odd to think about creating something that incorporated solar panels. *Sun Boxes* was my contribution.

Sun Boxes is a solar powered sound installation. Each Box contains an audio speaker, an amplifier, software, an audio sample of a single guitar note, and a solar panel. As long

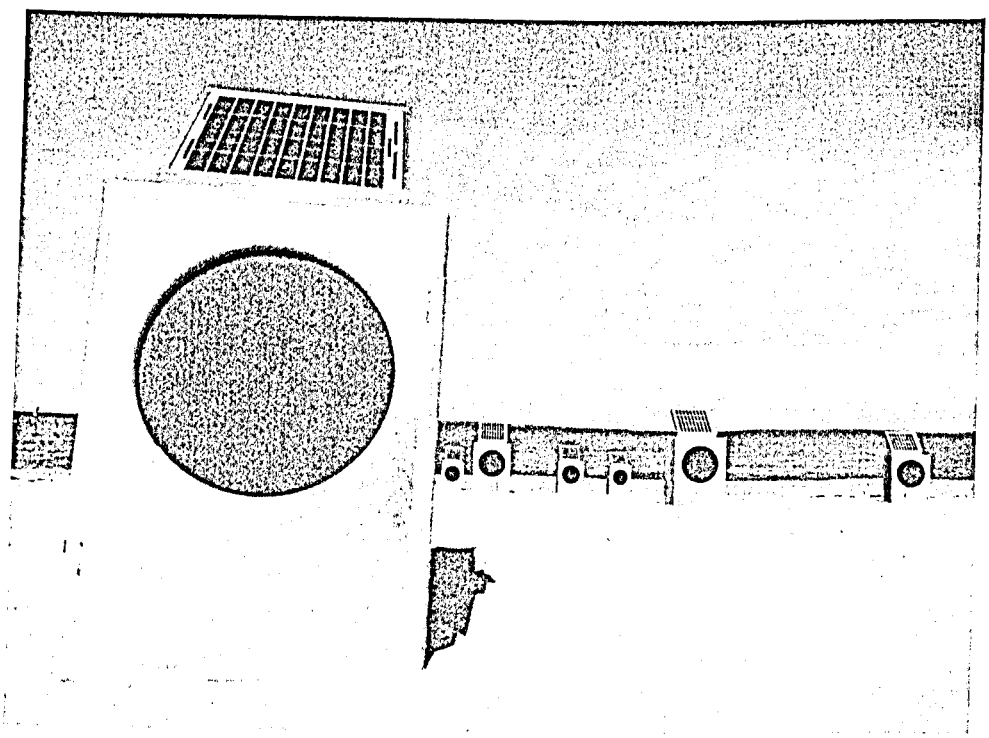


FIGURE 10.1 On Martha's Vineyard, Lambert's Cove.

as there's enough power, the twenty Boxes will produce sound continuously. When the sun is present, the solar energy provides power to the Boxes, resulting in the collective sounding of a Bb6 chord.

Sun Boxes was an opportunity to create something with sound that didn't require a traditional stage. When you see or hear *Sun Boxes* positioned in the environment, you become part of it. The work was designed to surround the audience while allowing them to move freely around the Boxes. The audience can navigate their own path and influence their personal sonic mix. As the audience moves around, they hear the continuously changing dynamic interplay between distant and closer Boxes. It is an evolving sonic composition.

The primary variable in *Sun Boxes* is volume. Because there are no batteries, volume is determined solely by the strength of the sun. More sun equals more power, and that translates into higher volume. On cloudy days, the piece sounds quite different. If the clouds are very dense, *Sun Boxes* can stop generating sound altogether. However, as soon as the sun breaks through the clouds, the Boxes will begin to play simultaneously. The first time it happened I freaked out!

One time, on a nice bright sunny day in the desert, a huge cloud hovered over *Sun Boxes*. The sound abruptly stopped and the entire installation of Boxes was completely silent. I quickly went down the list of all the possible things I did wrong. Were the solar panels the wrong size, the guitar notes not recorded properly, was the wiring not right, or perhaps a software problem? "Sexy" David Sanchez, always ultra cool, leaned over and said, "Hey man, just relax...." Sure enough, ten minutes later the cloud floated away and all the Boxes roared simultaneously, all starting on cue. It was really beautiful!

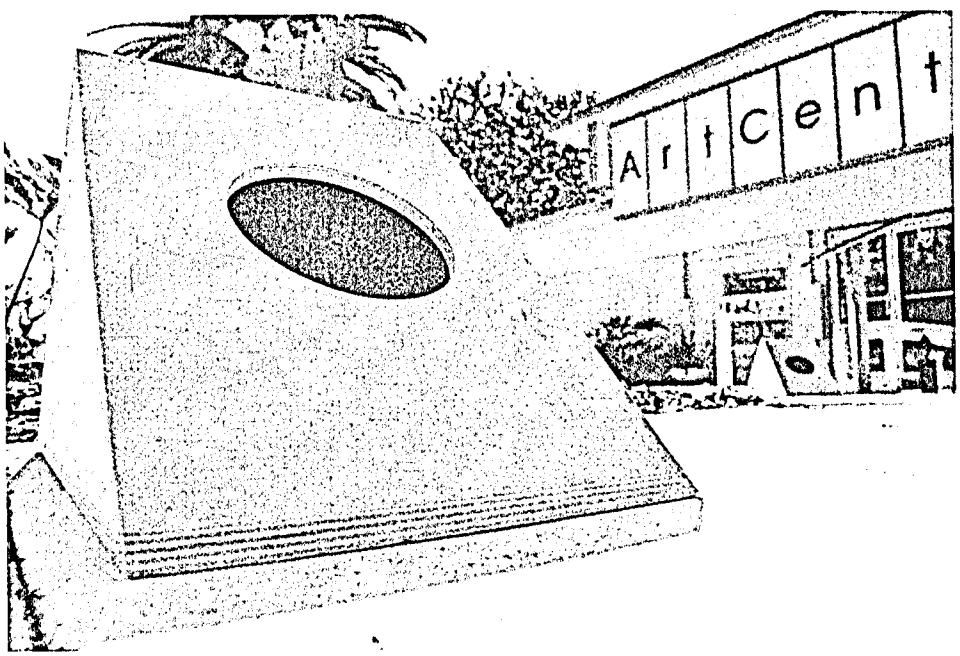


FIGURE 10.2 Art Center Sarasota, Sarasota, Florida.

I wish I could say I was a genius and meant for that to happen, but I'm not. While planning the piece, I considered whether or not to have *Sun Boxes* contain a battery. However, because the music was meant for daytime listening, a battery system would have allowed the sound to continue into the night. For that one reason, I decided on direct sunlight as the power source. When the sun sets, the piece stops. However, every location is different and there are various ways the sun can be obscured, including buildings, tree lines, mountains, etc. Because of trees and buildings, alleyways of sunlight are often created as the sun moves. When this happens, I sometimes move the Boxes into the path of light. It becomes choreography of chasing light. Other times, in more wide-open spaces, the Boxes just need to be rotated to follow the sun across the sky. But, in all cases, when the sun is obscured, there is no sound. It's a threshold, a moment between day and night, sound and silence.

Likewise, a dense cloud can also silence *Sun Boxes*. Because this happens every so often, it has made me a very patient person. This wasn't an intention, but I love the idea that sometimes in life you don't get what you want when you want it. It is nice to be reminded of this. I now have a different relationship to the planet. I wake up every morning, and it's either a good day for *Sun Boxes* or it isn't. My constant weather awareness and sensibilities make me feel like a farmer.

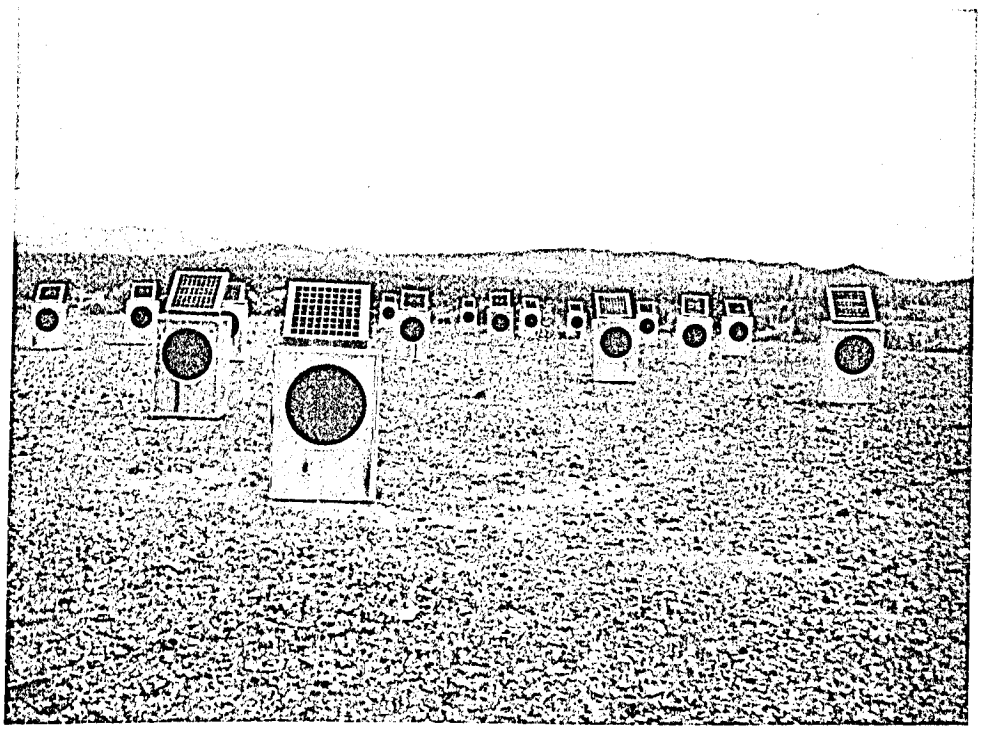


FIGURE 10.3 Goldwell Open Air Museum, Rhyolite, Nevada.

People often ask why I don't do more to manipulate the outcome of the piece. My answer is simple; "I'm just trying to get out of the way." *Sun Boxes* is a system that improvises with Mother Nature. There have been so many amazing moments that I could have never predicted. If I tried to alter the outcome, I might miss something beautiful.

One day, I did a *Sun Boxes* photo shoot on the Brooklyn Bridge with a few friends. It was a very overcast day and the Boxes weren't making any sound. While moving some Boxes, an onlooker seemed upset and felt as if he was missing out on something. He said, "You gotta figure out how to makes this work without the sun. Isn't the point for me to hear it?" I politely said, "I think the point of *Sun Boxes* is to collaborate with Mother Nature and make something beautiful. And right now she wants it to be quiet. We really have nothing to do with it." He wasn't as satisfied with this explanation as I was.

Most people seem to really enjoy the piece. *Sun Boxes* has been to forty-nine cities in eighteen different states in a variety of settings including, museums, universities, and state and national parks. Sometimes, people cluster outside the array of *Sun Boxes* and distance themselves like it's a traditional performance. When I see this, I try and encourage them to wander in, move about and experience the sound. During a tour of state parks in Vermont, a guy was appalled by the concept of *Sun Boxes* after reading about it in the paper. He got so mad that he was determined to come down to one of the parks and tell me so. As he was telling me all of this, a smile grew on his face. He said that when he arrived and actually experienced *Sun Boxes*, he thought it was one of the greatest things he's ever heard. So, look at that, *Sun Boxes* making converts in Vermont.

Many people also comment that *Sun Boxes* has altered a physical space they've been familiar with for years. *Sun Boxes* doesn't just take over a space, it interacts with what's already there. While the sound of *Sun Boxes* is loud enough to engulf the participants, there's also enough room and space for ambient sounds to be part of the sonic experience. One time, in Turner's Falls, Massachusetts, an ambulance raced by with sirens full bore. It was amazing to hear the sirens as they drove right by *Sun Boxes*. It was a bombastic moment that sounded like it was composed.

The Bb6 chord that emanates from the Boxes is a great chord. Because the piece was intended to be heard during the day, I was after something that sounded like daytime. Something up-lifting. I began experimenting in the key of Bb and recorded a variety of chords. The Bb6 sounded perfect. Because there's a tinge of dissonance in that chord, it allows observers to wander down a thought-provoking path. But, ultimately the chord resolves and soothes. The sound of *Sun Boxes* is simultaneously soothing and energizing, not unlike yoga or meditation.

Photo by Franc Palaia

Joseph Bertolozzi has forged a unique identity as a twenty-first-century composer with works ranging from solo gongs to symphony orchestra to architectural installations. He achieved international attention with *Tower Music*, which uses the Eiffel Tower as his musical instrument. As an environmental sound artist, Bertolozzi sees architectural structures both as iconic monuments and as pseudo-gamelans with limitless sonic potential. It is Bertolozzi's long-practiced and sharpened skills as a performing musician that allows him to conceptualize and auralize the sonic possibilities deeply hidden in these structures.

Growing up, Bertolozzi began organ lessons to learn how to notate the compositions he aspired to create. He became a skilled performer, concertizing across the United States and Europe on some of the finest and oldest organs in the world, including St. Peter's Basilica in Vatican City.

11

Bridge Music and *Tower Music*

I am a composer by choice, an environmental sound artist by default. Not professing any doctrine or system, I continue to write for standard acoustic instruments but also see music in many non-traditional manifestations, without drawing distinctions between them. My most recent works for suspension bridge, *Bridge Music* and the Eiffel Tower, *Tower Music,* or *Musique de la Tour* are simply extensions of my love affair with music.

Bridge Music and *Tower Music* are unique in that they are fixed musical compositions that can be reproduced live in concert using only the sounds created by physically playing the surfaces of the Franklin Delano Roosevelt "Mid Hudson" Bridge and the Eiffel Tower. There is no further manipulation of the audio signal. All the musical precedents I know of using engineered structures (works by Bill Fontana, China Blue, Einstürzende Neubauten, Glenn Weyant, Jodi Rose, etc.) are either ambient, processed with effects, improvisatory or some combination of those. I don't dismiss ambient music or processed audio, indeed I foresee working that way in the future with my sample libraries. But from the outset I wanted to write pieces that the public would hear as music *first* and then ask: "what is that odd instrument?" Why use the Mid Hudson Bridge or the Eiffel Tower at all if the sounds are unrecognizable? The point is to play and hear the physical structure, that's the attraction. Establish their original voices *then* perhaps modulate and process them. This specific aesthetic was paramount to the acceptance of *Tower Music* by The Eiffel Tower Operating Company. They wanted music that sounded only like the Eiffel Tower. It was my task to draw out the personality of the Tower through its natural sounds.

Bridge Music

One afternoon in 2004, my wife was mimicking the way I swing my arms when I play my solo percussion rig *The Bronze Collection:* an assemblage of over 60 gongs and cymbals. Standing next to a poster of the Eiffel Tower, she took a mock swing at it and said out loud "bong!" The epiphany was instantaneous. Of course! Everything vibrates! If one could identify and catalog the sounds of the Eiffel Tower according to its musical tones, recognizable music would result. It would be a massively impressive project to bring to fruition and would be fun too.

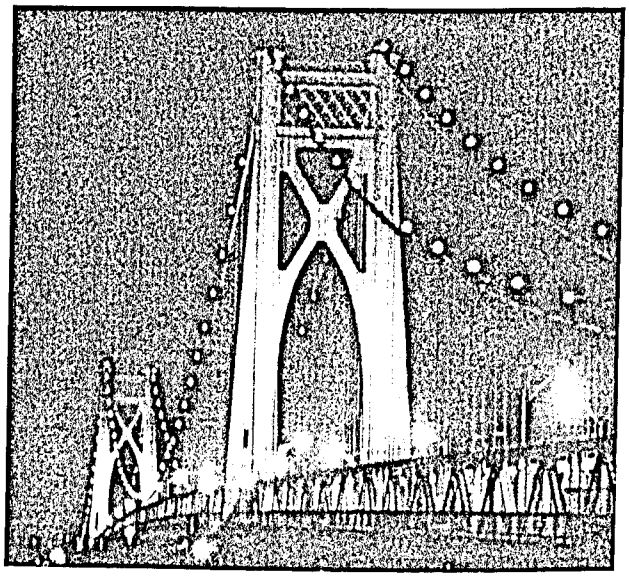


FIGURE 11.1 Mid-Hudson Bridge necklace lights. (Use of photo permission granted by New York State Bridge Authority)

However, I realized that I didn't speak French and had no connections in Paris. So hmm, how could this work? How does one approach the custodians of a world treasure and persuade them to let you have at it with hammers, mallets, and logs?

It was an unlikely premise, but I was exuberant about it and undertook to make it happen first in the USA. But what analogous structures do we have in this country that aren't faux reproductions of the Eiffel Tower as in EPCOT or Las Vegas? The St. Louis Arch, the Statue of Liberty... these crossed my mind. Then I remembered Gustav Eiffel was a famous bridge architect/builder and that the Henry Hudson Quadricentennial was approaching in five years. A bridge over the Hudson River made sense and could be included as part of any planned-for observances. Ultimately I chose the Franklin Delano Roosevelt "Mid Hudson" Bridge because most of its "playing" surfaces were easily reached from the pedestrian sidewalk, and its shores were close together and suitable for an audience at the live event. I also liked the visual of the suspension bridge, with its sloping cables suggesting a harp. When I asked Mayor Cozean of Poughkeepsie what she saw when she looked at the bridge, besides transportation infrastructure, she said "a target"... the events of September 11, 2001 were still fresh in everyone's mind.

It wasn't lost on me that a request such as I was about to make of the New York State Bridge Authority would certainly put me on their radar as a kook, or worse. When I was told years later that they had run an INTERPOL search on me, it proved my instincts were not far off the mark. I had to present myself as a legitimate musician with an admittedly unusual idea who also had their best interests in mind. It was important to prove this wasn't some whim. I studied bridge construction and learned the nomenclature so that I could speak to them intelligently. Comically, my main resource was a book printed

in England which, unbeknownst to me, used British English terms for the bridge's structural components rather than American English. I later found out that, as if I wasn't being pretentious enough, I was unintentionally referring to the Bridge's architecture in slightly foreign terms.

Ultimately, they asked me what I wanted from them. I requested three days access to record audio samples of the Bridge surfaces, after which I would use the samples to create a demo composition to prove my concept. If they didn't like the music after that point, we'd be done, no harm, no foul. If, however, they *did* like it, I'd then want permission to use their name in fundraising for the completion of the project, including a live concert.

Well of course I'm telling this story because they liked it, but there were still serious issues to overcome. There were three large tasks to complete in realizing a live concert. The first was composing the music and preparing a score and set of parts for the live musicians to play from. The second was creating audio files of that music for the musicians and audio engineers to guide them in what they'd be playing/mixing. This was mostly because the musicians would be spread out hundreds of feet apart, not able to hear or see one another. In fact, communicating via in-ear monitors would be necessary. Technology has progressed so much since I started that now we'd be able to have the printed music itself on a digital tablet with an inset view of the conductor keeping everyone together. Thirdly, there was the issue of financing such an undertaking, which would have to include not only musician and tech salaries, but insurance, audio trucks (at $20,000 per day for five days!), permits, and myriad other things.

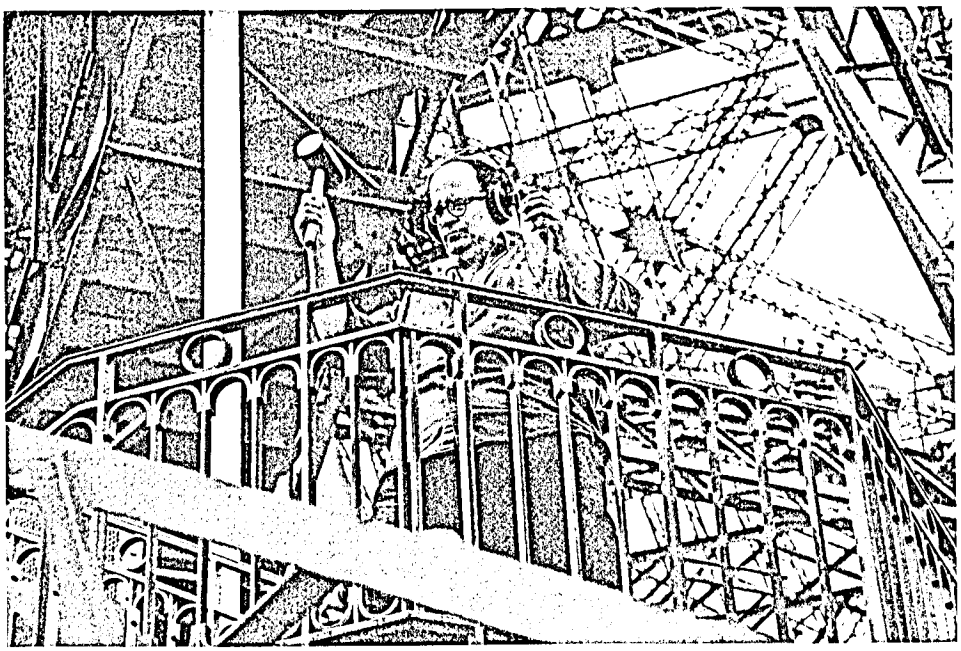


FIGURE 11.2 Joseph Bertolozzi at the Eiffel Tower stair landing. (© 2013, Franc Palaia)

Clearly the last item, financing, would have to involve corporate sponsorships. I learned that corporations allocate their advertising dollars roughly a year ahead of time by quarter. The signature event which would have included the live *Bridge Music* performance for the Hudson-Fulton-Champlain Quadricentennial celebration (as it came to be known) was slated for September 2009. This meant getting my project in front of the right eyes by the third quarter of 2008. Well, as if the national economy wasn't already in a bad way, this was the precise moment when the Bernard Madoff scandal broke loose and the *global* economy went into its great recession. To be honest, companies weren't exactly lining up to sponsor *Bridge Music* but I was making inroads. However on a daily basis as I read the paper, one company after another with which I had initiated a dialog was verging on bankruptcy, fending off mass strikes or involved in hostile takeovers. The ranks were closing and no one was parting with any money.

I could have left it at that, as a noble failure, but I saw a way to salvage everything even if the live concert was off. It was always in my long-range plan to leave a legacy of *Bridge Music* by having some sort of delivery system for the music to be heard on demand. The current installation consists of Listening Stations on the bridge as well as Park Radios. I had always thought this would come after the live concert: a permanent sound art installation experienced by walking out on the northbound pedestrian sidewalk of the Mid Hudson Bridge and pressing a button on one of the Listening Stations. It is essentially a giant jukebox mounted directly to the Bridge tower with signage for titles, information and descriptions of what you're hearing. For those afraid of heights or bridges, who have trouble walking distances, or arrive in bad weather, there's signage in the parks that flank the bridge with the direction to tune to 95.3FM for a radio broadcast that can be heard in the comfort of your car. The Listening Stations are active from April through October while the Park Radios run year round.

Tower Music

I am often asked "how can you write for a bridge or a tower?" I like to compose. I'm good at it. So to create music from the clangs and booms of a suspension bridge is not an issue at all, it's the exciting part. The recipe (if not the execution) is simple:

1. record the physical surfaces of the structure
2. catalog their musical properties
3. select the sounds
4. compose

It's not unlike the Wright Brothers building an airplane in their bicycle shop after hours: take existing components and combine them in new ways to create a new entity.

About a year after *Bridge Music*'s grand opening, I bemusedly recalled that this whole thing started because I wanted to play the Eiffel Tower. It took about a second for the wheels to start turning... *oh boy, here we go again* ....

Though there's a deep challenge in writing music for something that's firstly not an instrument and secondly incomplete as an instrument and then making it sound like it's not missing anything, the real work comes in convincing decidedly non-artistically driven public entities that something like this is in their interest. Without their blessing, I would have no project. I had no idea how much work was ahead of me for *Bridge Music*, but it served me in good stead when the time came to navigate the international politics of acquiring access to the national symbol of France; the Eiffel Tower.

I'd have to prove the project's worth to The Eiffel Tower Operating Company's mission AND rise above the noise. The Eiffel Tower gets hundreds of projects pitched to it every year, most of them in the realm of visual arts and design. But mine was a musical project, something out of the ordinary and integral to the Tower itself. With *Bridge Music*, I had a successful proof-of-concept. It behooved me to keep the momentum going while the tremendous press for *Bridge Music* was still fresh. So I dragged myself to the computer and searched for the owner or administrator of the Eiffel Tower. I discovered that the Mayor of Paris is nominally in charge of everything that happens within the city.

My friend at Vassar College, Peter Leonard, put me in touch with Christine Reno, the French Department chair. Christine graciously translated my proposal into elegant French so I could approach Mayor Delanoë with respect. I called his office to introduce myself to his secretary and ask her to please watch for my proposal and the package I was mailing. I sent the package to his office, waited, then called and emailed to see if it arrived; it hadn't. *I did this six times with six separate mailings.* It was an omen of things to come.

If you ever have to deal with the French government, there's one thing you must have in great abundance: a cheerful patience. Everyone I dealt with was gracious to the *nth* degree, but there is just no sense of time as Americans know it. I ended up actually getting to the Eiffel Tower three and a half years after my initial contact, and that was quick!

During that time, I labored mightily to acquire partners to offset the financial burden of the project. This included companies and corporations who might have an interest in associating their brand with a world monument, to universities seeking prestige in offering their students something that no other school in the world could offer. It also included contacting artist management agencies who could promote the total media package: the music, the concert, the book, the film, etc. There were just no takers.

I went back to my beloved and loyal fan base and asked for their help. They have come through over and over and this time was no different. They helped me raise the money for my eight-member team to get to Paris, plus some extra for the necessary studio time to complete the album.

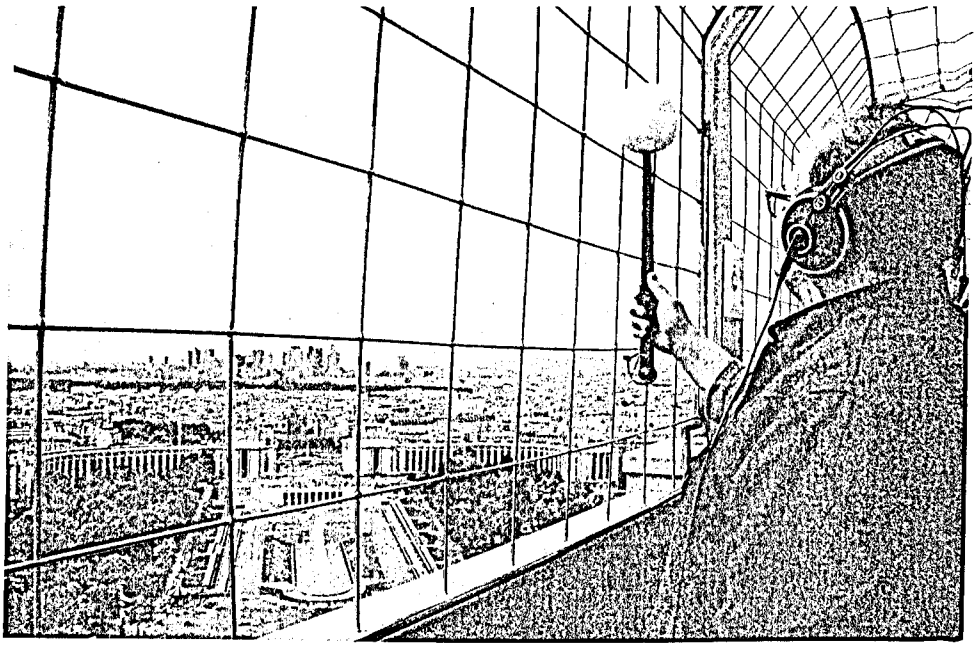


FIGURE 11.3 Joseph Bertolozzi banging the fence at the Eiffel Tower. (©2013, Franc Palaia)

Why so many people on my team? Admittedly, I created *Bridge Music* with just myself, audio engineer Ron Kuhnke, and a massive amount of detailed pre-production planning. However, I knew that I'd have a limited amount of time on the Eiffel Tower to harvest at least three times as many audio samples as I did on the Bridge. In the end it was more than that, about one to two thousand samples from the Bridge versus almost ten thousand samples from the Tower. I'd need people who would help me make the most of my limited time on the Eiffel Tower.

My job was to identify the surfaces of the Tower to sample, play them, and listen critically to the character and quality of the attacks. Audio engineer, Paul Kozel, set the levels, did the actual audio capturing and listened for the overall audio quality. A second audio engineer, Joe Popp, affixed the microphones, listened for the sound decay to cue me when to play the next hit and took photos to document their placement for the proposed live event. Production Assistant Jeff Gertin was our archivist, logging our geographic locations and tracking our sessions by day/scene/take. For example, Floor 2, Level 1, North Leg Panel on rivets, etc. The individual takes were further articulated into hits-per-take, from which I'd later select the most useful ones. Some takes had only four hits to choose from. Others had as many as nineteen. The average was about seven. Here's the breakdown showing how many hits we recorded in a day (DAILY TOTAL) and how many sounds I ultimately selected as my *go-to* choices (YIELD). The count is approximate:

DAY	DAILY TOTAL	YIELD
1	828	170
2	670	260
3	963	350
4	660	220
5	1400	372
6	800	206
7	1450	320
8	496	124
9	1040	260
10	1440	384
11	200	75
Total	9967	2832

Franc Palaia and Joseph Redwood-Martinez served as photographer and videographer respectively, while Kyle Griffin acted as an onsite producer liaising with The Eiffel Tower Operating Company. Robert Bellach served as a social media specialist, handled curious onlookers, did maintenance on the drumsticks and mallets, etc.

All of us routinely worked twelve-hour days, spending most of our time onsite. After dinner, we'd put in four to five hours copying and backing-up the day's work, running around Paris to replenish supplies, interacting with the media, and delivering reports to The Eiffel Tower Operating Company, etc., I don't think I could have accomplished what I did without every member of the team being there.

Upon returning to the United States, it took from July 24 to November 21 to sort through all the audio samples. My goal was to collect at least six working samples of each Tower surface: two examples each at loud, medium and soft dynamics. I would choose one beautiful sound and one *representative sound* if the beautiful one was a fluke! Sometimes I had two great takes, and sometimes up to five or six. By the way, that's at least six samples from a single type of actuator: a wooden dowel, a latex-sleeved dowel, a latex mallet, a drumstick, a rubber hammer, etc. I sometimes had to listen to150 hits on the same surface with minuscule variations of sound between them. It was a great thing to find several usable takes especially in the case of continually evolving sounds like long-ringing fences or panels.

On the other hand, there were instances where whole sessions were ruined because of so much ground noise. Though we used contact microphones that picked up the vibrations of the Tower surfaces (rather than sound in the air), many of the surfaces picked up vibrations from people walking by or school children and tourists shouting. The team of course was aware of this issue and we purposely re-visited several areas of the Tower to try to get clean recordings.

Another element contributing to the length of the process was that each of the ten thousand audio samples had to be listened to in real time, appraised, compared to one another, culled, and then edited to fade in and out. I could easily spend forty minutes or more on a single pair of samples. Make a mistake and you'd have to start over again.

Then there was the task of naming the sounds. They had to be entered into a music notation program and tagged with an English-language description. Here's one that isn't even as complicated as some of the others: SUMMIT-CHAMBER/PANEL-BOTTOM/BASS DRUM/MED. HIT CONTAINS ALTO "E" OVERTONE/HARDER HITS CONTAIN "E-Bb" TRITONE/FELT MALLET- 7SC1T01-05.

It was clear, however, that the actual file names couldn't be so long. Going back in to comprehensibly abbreviate them added more time to the process. The file name of the description above reads: "7SC1T01 – 2.1 BD-ALT E, PANEL BOT, FELT M." Translated it tells me this is from Day 7, Scene 1, Take 01. "2.1" indicates the first of two saved hits. "FELT" means the actuator or type of mallet used and "M" demonstrates a medium-intensity strike, i.e.: H(ard), M(edium) or S(oft). Though the words "SUMMIT / CHAMBER" do not appear in this abbreviation, the sample itself resides in the SUMMIT-CHAMBER subfolder indicating it is on Level 2 of the Summit.

I of course still had to work for a living, so after returning to the States, I didn't have uninterrupted time for cataloging all of the sounds. Even though I cleared my schedule as much as I could, sometimes days would go by before I could sit in my studio and work. Also, one has to take breaks because ear-fatigue sets in during extended bouts of critical listening. All this is necessary groundwork before a single note can be composed.

The public reception of *Bridge Music* was overwhelmingly positive. The installation is a noted tourist destination and the album went to #18 on the Billboard Classical Crossover Chart. The press began writing about it while I was still in the sampling stage, when there was only one track available to demonstrate the concept, "Bridge Funk." When the New York Times came to cover it, the story unexpectedly turned up on page one of the Sunday Arts Section. That engendered a whole summer of interviews from the Reuters news agency to the BBC, to Russian newspapers, Japanese TV, Swedish, Norwegian and German radio, all of which in turn was picked up by other media. There were articles from China to Poland, from Brazil to Australia. After each of these interviews I asked the reporters if they wanted me to keep them apprised of any progress I might have with *Tower Music*. To a one they said yes. So, I let them know as I progressed from inquiries, to meetings, to my partnership with The Eiffel Tower Operating Company.

Once again, the New York Times ran a cover story in the Arts Section, but this time around digital news had become more prevalent and *Tower Music* was the *lead story* on page 1 of the cover of the digital issue. I was deluged with press wanting to follow the story. All this happened without a PR campaign and before a single note had been written.

The entire project has been a blessing ...

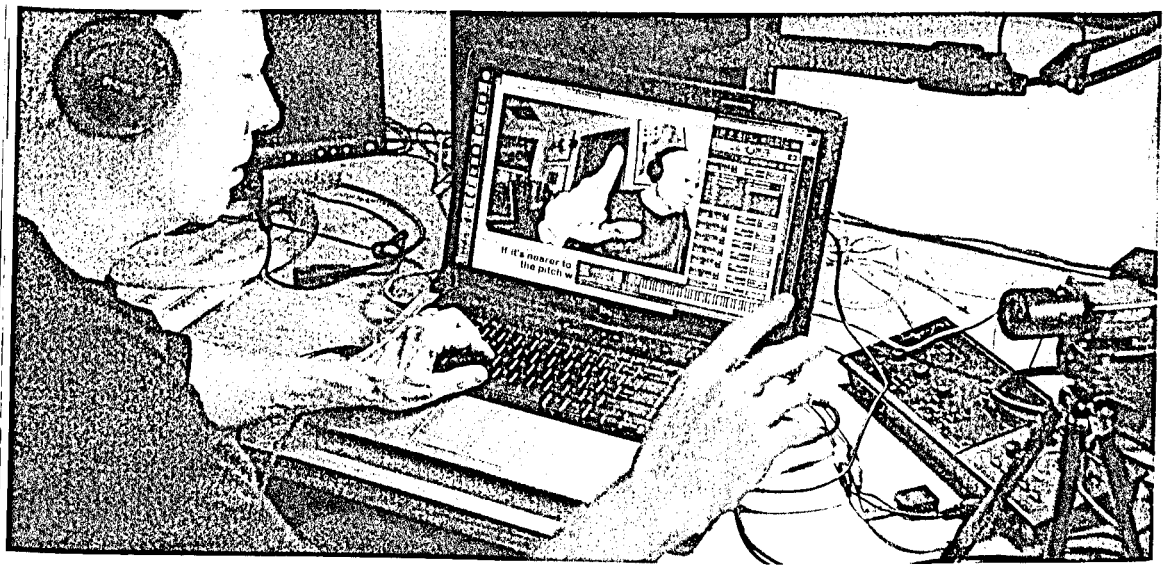


Photo by Mike Routhier

Marty Quinn is an environmental sound artist, computer scientist, composer, visual artist, dancer, and sonification researcher specializing in transforming scientific data into music. Quinn's work addresses many of the core issues associated with sonification, including how data can be perceived as music. As a pioneer in sonification, Quinn articulates the complexities in mapping data to musical parameters and the logic behind some of these multidimensional relationships.

Quinn is the founder of Design Rhythmics Sonification Research Lab and has collaborated with scientists at the Venice Marine Institute, the Climate Change Research Center and Space Plasma Group of the University of New Hampshire, and the Lunar and Planetary Lab at the University of Arizona. Quinn has won three NASA grants related to improving accessibility of data and imagery for the visually impaired.

12

Data as Music

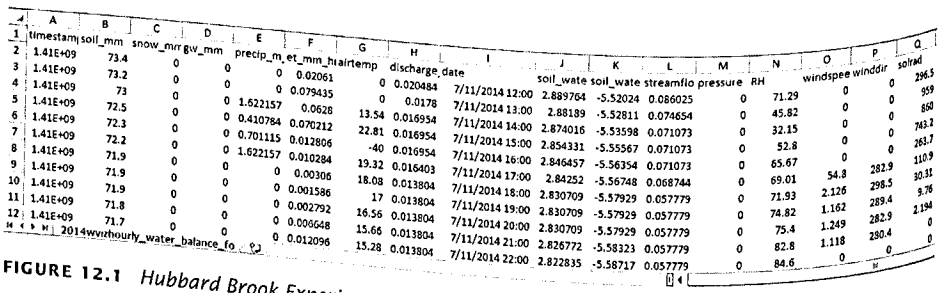
Why Musically Encoded Sonification Design Offers a Rich Palette for Information Display

For the past twenty-five years, I've been exploring how data of all kinds can be perceived as music. Why music? Not only do we as humans love music and listen to it 24/7, but music is comprised of a rich set of audio qualities—as rich as visual characteristics—that can be combined to create musical worlds through which data, like the invisible wind that informs us of its presence as it blows thru wind chimes, can be heard as a kind of information soundtrack.

If we design this world with musical care, including knowledge of scales, instrument timbres, tempos, and rhythms, plus a limited set of rules that describe how the musical world will change as data at different levels of intensity interacts with it, then the resulting music becomes an auditory information channel.

Looking at a few of the projects I have sonified over the years, we can explore and discover their sonic world through an examination of the information design principles applied to each one. The data for each project was usually presented as one or more time series datasets in the form of spreadsheets where each column of data has a particular meaning attached to its rows of data values. All the data is recorded by various remote-sensing instruments at a particular time or are post-calculated derived values.

For example, Figure 12.1 shows the basic layout of the data used for the *Hubbard Brook Experimental Forest* sonifications and the *Hubbard Brook Listen Live* internet radio station. In the first row we see the meaning of each data column: timestamp, soil_mm, snow_mm, gw_mm, precip, etc. Oftentimes, I will go back and forth with the scientists to make sure I understand the meaning of each column and what is most important to them.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	timestam	soil_mm	snow_mm	gw_mm	precip_m	et_mm_h	airtemp	discharge	date		soil_wate	soil_wate	streamflo	pressure	RH	windspee	winddir	solrad
2	1.41E+09	73.4	0	0	0	0.02061	0	0.020484	7/11/2014 12:00	2.889764	-5.52024	0.086025	0	71.29	0	0	0	296.5
3	1.41E+09	73.2	0	0	0	0.079435	0	0.0178	7/11/2014 13:00	2.88189	-5.52811	0.074654	0	45.82	0	0	0	959
4	1.41E+09	73	0	0	1.622157	0.0628	13.54	0.016954	7/11/2014 14:00	2.874016	-5.53598	0.071073	0	32.15	0	0	0	860
5	1.41E+09	72.5	0	0	0.410784	0.070212	22.81	0.016954	7/11/2014 15:00	2.854331	-5.55567	0.071073	0	52.8	0	0	0	743.2
6	1.41E+09	72.3	0	0	0.701115	0.012806	-40	0.016954	7/11/2014 16:00	2.846457	-5.56354	0.071073	0	65.67	0	0	0	263.7
7	1.41E+09	72.2	0	0	1.622157	0.010284	19.32	0.016403	7/11/2014 17:00	2.84252	-5.56748	0.068744	0	69.01	54.8	282.9	90.31	110.9
8	1.41E+09	71.9	0	0	0	0.00306	18.08	0.013804	7/11/2014 18:00	2.830709	-5.57929	0.057779	0	71.93	2.126	298.5	9.76	
9	1.41E+09	71.9	0	0	0	0.001586	17	0.013804	7/11/2014 19:00	2.830709	-5.57929	0.057779	0	74.82	1.162	289.4	2.194	
10	1.41E+09	71.9	0	0	0	0.002792	16.56	0.013804	7/11/2014 20:00	2.830709	-5.57929	0.057779	0	75.4	1.249	282.9	0	
11	1.41E+09	71.8	0	0	0	0.006648	15.66	0.013804	7/11/2014 21:00	2.826772	-5.58323	0.057779	0	82.8	1.118	280.4	0	
12	1.41E+09	71.7	0	0	0	0.012096	15.28	0.013804	7/11/2014 22:00	2.822835	-5.58717	0.057779	0	84.6	0	0	0	

H ◀ ▶ H | 2014wyirhourly_water_balance_fo ⟲ ⟳

FIGURE 12.1 *Hubbard Brook Experimental Forest* Data Spreadsheet.

Audio Information Design Issues

There are many design issues and questions involved in choosing how to sonify such datasets. Do you want the listener to be able to discriminate amongst the data columns, i.e. to perceive separately the meaning of each column or is it better to integrate the presentation of the columns? For instance, is it important to hear the levels of different kinds of fish, or to hear the levels of all fish combined? Is there a goal to hear all columns at the same time, or can data be spread out and presented sequentially, with one column's values followed by a different column's values? In what form will the data be presented? Will it sound like a song, a symphony, a measure of music, a sound-effect, a theme, chords, melodies or rhythms or combinations of these and/or will it remind the listener of a type of music: jazz, rock, ethnic, classical, new age, new music, or other?

Other questions arise: how long will it take to perceive some quantum of information? Does the design have a cognitive goal targeting data perception and comprehension? Will it take 1.2 seconds per month, per 10 degree latitude strip to perceive 6 variables related to the changing surface of Mars, or 10 seconds to perceive the last 4 days of forest and weather related variables from *Hubbard Brook Experimental Forest*? In what form will the sonification be packaged? On the web as a static mp3 allowing one to study various galactic spectral signatures, a dynamic flash presentation based on premixed mp3s such as *Water Ice on Mars,* or as real time Internet radio stations such as *CRaTER Live* and *Hubbard Brook Listen Live*? How will the user know something important has occurred? How will they know the data has changed versus staying the same? Which musical qualities will express data characteristics of meaning, value, metadata, relationship, or timing? How loud will the sonification be? Will volume be used in any way to express those data characteristics?

To summarize, the issues fall into the following design dimensions:

1. Concurrency vs. Sequential
2. Discrimination vs. Integration
3. Tempo
4. Audio Form
5. Delivery Mechanism
6. Change vs. Stasis

7. Dynamics
8. Instrument selection
9. Audio mix
10. Scale selection
11. Rhythm selection

In a real sense, every musically encoded sonification designer must decide upon these 11 dimensions or factors before a sound is ever realized. This is what makes this style of sonification potentially so rich and interesting. Though it may seem rather complicated to convey to the listener all the rules and decisions that go into a sonification, it is not all that different from the graphic key of a visual map or graph. The difference lies in the fact that we are actually taught what various visual graphs mean from a young age and musically-encoded sonifications are new creations, new cognitive constructs that require explanation to be useful as powerful, auditory data communication vehicles.

For instance, what does it mean that I can now tune into *CRaTER Live* Internet Radio station, and hear the level of cosmic rays at the moon? In the future, we will be working on the moon, and instead of having to look at a radiation meter on one's wristwatch, one could monitor the radiation environment as music. It's simple, carries a significant amount of information in one second including the relationship amongst 6 detectors on board an orbiting spacecraft, whether the data is stale (the spacecraft is on the other side of the moon or the space network is not allocated to Lunar Reconnaissance Orbiter at the moment) or live, and the magnitude of the counts. Based on this one second I can decide whether the levels are safe or whether a solar storm is hitting the moon and that I should take immediate cover. On earth it could also inform me that there may be increased northern lights or that satellite communications may be in danger. In ballet class, we recently performed rond de jambe during bar to this particular music of the spheres, bringing delight to the dancers. In a sense, *CRaTER Live* (Fig. 12.2) is similar to a geiger counter, but carries more information due to the use of multiple timbres, multiple scales, a measured sequential presentation of the six detectors over 1 second and a polyphonic presentation of multiple metadata variables (the magnitude of the counts and the stale/live flag) simultaneously. It expands our cognition of our global space environment.

I strive to create every sonification experience so that 1) the data presented in audio form can be perceived within a targeted number of seconds, 2) that the audio has musical qualities, and 3) that it is interesting to listen to for long periods of time. While the transformation of data through audification creates interesting noise, and allows for the effective discovery of subtle cycles that may be present in data, I feel I can generally hear more information in data through musical transformation. For instance, if we convert an image of deep space into spectral noise, through some algorithm, it will sound like structured noise. Perhaps my hearing of the structured noise isn't developed enough, but I can't pick out or discriminate the data like I can by turning it into music. In *Walk on the Sun*, I turned images of the sun and space into music by mapping color to instrument, brightness to pitch in scales, and

FIGURE 12.2 Marty Quinn in front of the CRaTER (Cosmic Ray Telescope for the Effects of Radiation) Spacecraft Operations Center at the University of New Hampshire holding the remote MIDI keyboard used for the interactive control of the *Walk on the Sun* exhibit.

saturation to small changes in volume. The result is that when scanning an image of deep space, I can hear all the colors and brightness present in the image through the various musical instruments—very clearly—and surprisingly better than my eyes. I was very surprised when I heard greens and blue greens present in an image of galaxy M100 (50 million light years away) when my "eyes" thought the image was composed only of black, white, blue, with some reds and yellow. It was gratifying to me to confirm this rather simple yet informative approach worked to allow persons who were blind to perceive the "blue content" in various and multiple images of nebulae and the sun. If the data can be heard and perceived as noise, I am all for it, but if I were to choose between listening to noise or music for long periods, I would choose music. The negative effects of listening to noise are also well documented.

My first data driven sonification was *The Climate Symphony*, based on 110,000 years of Earth's ice core record from the GISP2 NSF project. *The Climate Symphony* was developed in association with and partly funded by the Climate Change Research Center at the University of New Hampshire. In some sense it is the most complex sonification design I have done and includes many design elements.

In this composition, 10 datasets derived from ice core samples from Greenland are expressed as musical themes and textures in a symphony. Many ranges of expressions are

employed to sonify the data, such as scales of pitches, scales of note patterns, and scales of rhythmic patterns. Merged sonifications convey the values of two or more data points in one sound. The music expresses 110,000 years of ice core history and moves from the past to present at the rate of 50 years per beat or chord. It was cited by the then Director of the National Science Foundation, Dr. Rita Colwell, for being an innovative merging of art and science. Thanks to Dr. Paul Mayewski, Former Director of the UNH Climate Change Research Center, and Dr. David Meeker, now retired UNH mathematician, who provided the data and insight into its meaning.

The music is based on 10 datasets derived from the mathematical analysis of ice core chemical ion records obtained by the Greenland Ice Sheet Project II. It begins 110,000 years ago and moves in steps of 50 years per row of data. It begins at the rate of 150 years a second for the first two minutes or 20,000 years and increases to 350 years a second for the remainder of the journey up to 1975 to give people time to adjust to listening to a fairly large number of simultaneous musical lines representing different climate cycles or effects. Each of the data files were comprised of 2209 data points. These points were calculated using principle component analysis of eight ion series found in the 2 mile long ice core. The overall duration is 7:40 minutes. The mapping from data to music for each dataset is described in Table 12.1.

TABLE 12.1 *The Climate Symphony* (GISP2 Datasets) Sonification Design

Climate Cycle in Years	Climate Meaning	Musical Instruments and Expression
>70,000	Elipticity of Earth Orbit	Transposes all pitched music 0 to 7 semitones.
36,500	Obliquity (Tilt of the Earth)	Five sets of 3 notes in 4th and 5th intervals. Each set is played as an arpeggio up and down. The 5 sets are considered a scale, so the lower sets are played when the earth has less tilt, higher sets are played when the earth has more tilt.
1450	Ocean Circulation	This data selects the instruments used to play the "tilt" notes using a scale of three instruments: clarinet, trumpet and muted trumpet.
21,000	Precession (Wobble of the earth; which hemisphere is closest to sun)	Lower two octaves of a C scale, lower values select lower notes. Played by a beautiful sustained organ tone.
11,400	Sub precession	Higher two octaves of a C scale, lower values play lower notes. Same tone as 21K.
6300	Ice Sheet Movement	Simple to complex patterns of two sets of 4 tom toms and 4 conga sounds play when it is warmer and values are lower. Selection orders are [1,2] [1,1,2,2], [1, 1, 1, 1, 2, 2, 2, 2]. Complex to simple patterns (same selections) of 2 agogo bells when it is cooler and values are higher.

(continued)

TABLE 12.1 *CONTINUED*

Climate Cycle in Years	Climate Meaning	Musical Instruments and Expression
3200	Sub harmonic of 6300	Closed hi-hat whose volume is controlled by data values.
550	Solar Variability	4 vibraphone patterns in two groups. Two sets of 6 and 12 higher notes complex patterns [1,2,2,1,3,2,2] when warmer. Two sets of 3 and 10 lower note simpler patterns [1,2] when colder, separated by an octave.
Random	Volcanic Activity	Crash cymbal and timpani drum hits whose volume is controlled by data values, louder means more activity. Also the lower the pitch of the timpani, the bigger the eruption.
Time (110,000 BC to 1975) in 50 year steps.	Time line	String section starting from very low note of a 5 octave C scale up to the highest note of that scale.

Another project was based on tidal data from Venice Italy during 2002 provided by Dr. Davide Tagliapetra of the Venice Marine Institute. In this sonification, the air pressure changes the scale used to sonify all the other data elements creating music which sounds like a film soundtrack, is fairly complex and quite beautiful. Two versions of this sonification were produced for the AirCraft music production libraries in surround sound, one using 7 notes scales and the other using pentatonic scales with vocal or shakuhatchi improvisation over the generated data music. The sonification design is outlined in Table 12.2.

Returning to the *Hubbard Brook Listen Live* internet radio station, we express the meaning or type of data through instrument timbre, and express the data value through that instrument's pitch. The pitches are selected from a 4 octave, mixolydian mode (see Table 12.3).

TABLE 12.2 *The Tides of Venice* Sonification Design

Climate Data Type	Instrument	Musical Expression	Low to high data values map to:
wind direction	flute	pitch. (3 octaves)	low to high pitch
wind temperature	french horn	pitch. (3 octaves)	low to high pitch
tidal level	lush string section	pitch. (middle range 2 octaves)	low to high pitch
humidity	String section	pitch. (high range 1 octave)	low to high pitch
humidity	tympani	Pitch and volume (high range 1 octave) When there is high humidity, you should be hearing a drum roll softly in the background	low to high pitch and very soft to mid volume

(continued)

TABLE 12.2 *CONTINUED*

Climate Data Type	Instrument	Musical Expression	Low to high data values map to:
air pressure	1. dramatic string section 2. Key of music 3. tympani	1. pitch. (lower octave) 2. 4 Scales. This changes the scale used for all the other data elements. 3. When the pressure changes, a ceremonial tympani drum is struck at the same pitch as the low strings to call attention to the fact the pressure is changing in some way. The low strings then sustain the value of the pressure, providing an audio contextual element and harmonic counterpoint underneath the melodic interplay of the tides, wind direction and temperature.	1. Low to high pitch 2. Major to minor scale change 3. low to high pitch
wind direction	sitar	pan	Left to right pan
wind velocity	sitar	volume	Soft to loud dynamics
wind temperature	sitar	pitch. (3 octaves)	Low to high pitch

TABLE 12.3 Hubbard Brook Listen Live Internet Radio Station Sonification Design

Forest Data	Instrument	Musical Expression
Temperature	Flute	Pitch moves up and down on a daily basis, with warmer temperatures corresponding to higher notes
Precipitation	Cymbals	Cymbal crashes (containing higher frequencies for larger events)
Stream Flow	Bass Guitar and French Horn	Bass guitar and french horn play only the stream flow data change points, plus every few seconds even if the data does not cause a different note to be produced. This creates a sustained feel in the bass without overwhelming the music by playing every single (and unchanging) data point value.
Soil Water	Guitar	Accents the changing levels in the data as follows: as the level/note stays the same, each following guitar note is lowered in volume down to a minimum volume and then stays at that level until the next change in data triggers a new note at normal volume.
Evapotranspiration	African Marimba (drum sound)	Bass-tenor african marimba (sounds like a drum and goes up and down during the daytime hours of the summer).
Snow Levels	Celeste	Celeste tones. Pitch moves up and down. These are only heard in winter
Wind Direction	Solo Violin	Pitches start low at 0 degrees North and move higher every 12.4 degress over 4 octaves or 29 notes moving thru 90 degrees (East), 180 (South), 270 (West). The highest pitch will be 359 degrees.

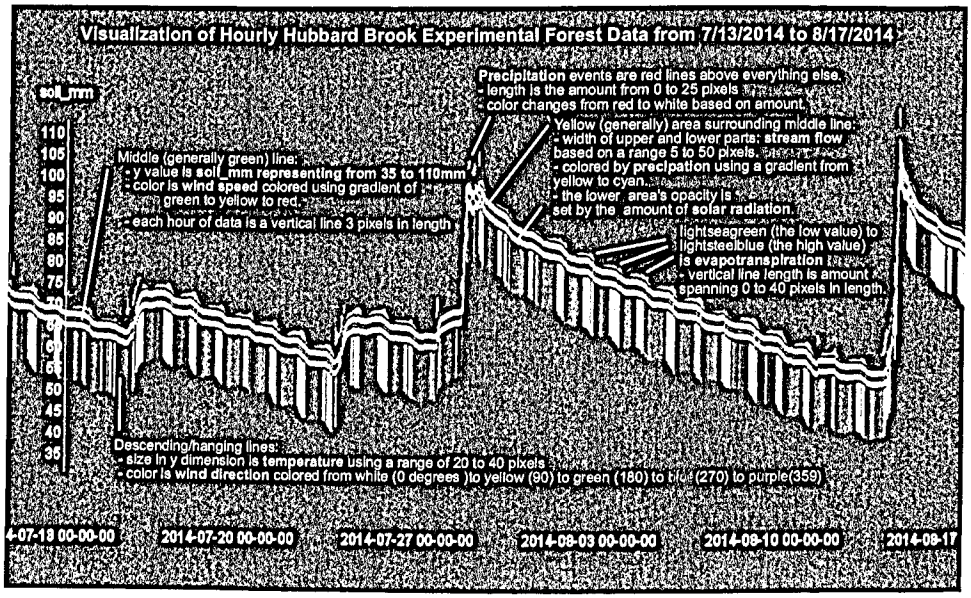


FIGURE 12.3 *The Hubbard Brook Listen Live* sonification design.

It is important to develop many sonifications and visualizations of the same data using different design choices. This will ensure a wide variety of data relationships are expressed in visual or sonic forms of the data. For example, in my recent Masters in Computer Science project at UNH, I developed a visualization of Hubbard Brook data using the D3 javascript library. I call it a Multiple Variable Encoded Line chart (see Fig. 12.3).

By visualizing data in this manner, I realized that my sonification design did not adequately express the day to day, step-like decreases in water levels in soil (the overall y-axis variable) in the changing pitch of the guitar during the summer months. Hence, there is a great benefit to be attained in expressing data using multi-modal, explorative approaches where one mode informs the other modes and vice versa. Also, during the process of working on a new dance performance piece that my wife, Wendy, and I are creating, we discovered a problem in the Hubbard Brook forest service data processing code as one of the values didn't sound right as well as a mapping bug in my C# sonification codeset. It is a rich environment when the arts and sciences interplay in this fashion, where each expression helps to validate the other and the information designs and processing evolve and improve as a result.

By transforming data into music we utilize the mind's ability to remember and recognize melody. We build upon data recognition by pitch through the mind's binning of pitches into scales, that for many people, they have learned over a lifetime of listening to music and attending school music programs. We can easily differentiate data categories

(temperature vs. humidity) through musical timbre, the "colors" of musical orchestration, and we can give the mind time to perceive through the presentation of the data as musical measures, where not all the data has to be presented simultaneously, but rather spread out over a targeted amount of time. We can present thousands of data points as chords of multitimbral music to present the ever-changing face of the sun, or hear climate as a symphony. I believe we have only begun to explore the perceptual opportunities afforded by transforming data into music and the limits of such musical perception by our brains.

Photo by Bruce Odland

Bruce Odland, sonic thinker, composer, has delved deeply into the sound of both wild and built environments since his first sound installations with pre-Columbian musical instruments and Anasazi acoustics in the late 1970s. Odland is an artist who thinks with his ears and, as a result, calls upon us to question our acceptance of living in a world designed primarily by visual thinkers and biased by what we see. Could we sharpen our hearing skills, focus our listening, and open a new world of perception and understanding of the amazing world around us?

Broadened by non-Western acoustic phenomenon, Odland has gone on to create large-scale works with Berlin-based Sam Auinger [O+A] that transform urban noise into harmonic fields of sound. He has used his "hearing perspective" of the world in collaborations with Peter Sellars, Laurie Anderson, Dan Graham, the Wooster Group, the Whitney, the Field Museum, and many permanent O+A installations worldwide.

13

Sonic Landscapes (finding a sense of place with my ears)

Since the shift from oral history to print, we have been hurtling down the "cultural optic nerve" with growing speed, hyper-stimulating the visual cortex as our main channel of cultural communication while the other senses retreat from public discourse. We accept living in a world built by visual thinkers as normal without questioning the results. But couldn't we develop a counterpoint to visual thinking by sharpening the observational skills of our other senses? Could we, for instance, learn to think with our ears?

When I was invited by CAD FACTORY's Vic McEwan to an artistic residency in the Old Birrego School in the Riverina, a part of Australia I had never heard of, I was intrigued. I was intrigued because I did not have a single visual image of this landscape in my brain. I would have the rare chance to experience arrival in a totally unfamiliar place and form an impression using my ears. So I decided to set out on a journey to test my perceptions. My goal: to restore the balance of my senses by really listening to where I am.

DAY 0: Sidney International Airport—Arrival in a Non-Place.

> "... *clattering of an ancient dot matrix printer, incessant blaring of a tinny television, roaring propellers through thick plate glass, suitcase wheels buzzing on metallic moving walkways, wailing children's voices echoing down a glass corridor, the shrill of a desperate announcer, high heels percussing a marble hallway....*"

No one is responsible for this mix. It's the sort of sonic accident found in any international airport. I sit helplessly alienated and unable to process. My journey has begun in the limbo of a Non-Place, both anywhere and nowhere. I hope to emerge soon, fresh and impressionable, in a real "Place," like Gulliver on a travel. Like Candid. Like a baby.

FIGURE 13.1 Bruce Odland with the Gum Tree Harp at Old Birrego School. (Photo by Vic McEwan)

DAY 1: Western Riverina—Hearing the Old Birrego School.

> *"... breeze is blowing through the trees. These are not familiar rattling, but slender leaves that swish like giant horses tails in a slow stereo sweep. I'm surprised to find I can hear the shape of the leaves ..."*
>
> *"Occasional passing cars rumble down worn pavement of a road too rough to be a main artery. A while later the passing of another car activates no reflections, no echoes, no reverberating forest, no slap back echoing from building walls– just the groaning motor and whining tire noise fading into the distance of open space. This is a lonely stretch of road."*
>
> *"A jet passes high above. Its engines drone their slow steady way across the sky, soundwaves unaltered by the shadows of clouds or complex reflections of mountains and valleys. The birds are singing exuberant unfamiliar morning songs. Another jet passes with the same simple steady sound. We must be under the flight path of distant airports on a sunny cloudless day on wide-open plains."*

What I don't hear is equally telling. There is no constant roar of commuter traffic, no rumble of train, no helicopters, no constant buzz of electric grid, no gray noise of

ventilation fans, no discernible sound of infrastructure. In this absence, the world of listening springs to the foreground.

DAY 2: An open field—Listening to the Song of the tree.

> *"Wind swirls through the treetop then sweeps through lower branches left to right. Branches near my head begin to shake in a near field clatter. It is a detailed spatial portrait of a tree painted by the wind, leaves vibrating in response to large weather systems, changes pressure creating local sworls, drawn ever eastward over the huge flat plains. The song of the tree never repeats itself. It has the dramatic arc of a symphony, the intimacy of a whispered story, the twists and turns of a good movie."*

I have become a willing audience to the details of a song with endless spatial variations. Maybe it is because no traffic sound covers up the subtleties, no fluorescent light or refrigerator puts me in a coma of non-listening, no industrial standing waves freeze my perceptions in place.

As we consumers continue to fill all available auditory space with the unplanned sounds of convenient machines that we turn on and never turn off, and as our nervous systems adapt to this soundscape, so does our music. It is no longer built from the arcs of the wind, the surge of the storm, but the steady and persistent rhythms of machines. The sway of the drummer—replaced by the drum machine. The imperfections of the string orchestra—replaced by the digital keyboard. Even the fluctuations and emotions of the singer's voice flattened into the synthetic auto-tuned robot.

We have lost the fear of the machine. It has turned to envy.

Day 4: The Murrumbidgee River—Mapping the mental soundscape.

Since arriving from the snowstorms of New York, I've stayed close to the schoolhouse compound with Vic, Sarah and their baby daughter. I've been slowly piecing together not a "picture" of where I am, but a sonic map. It is taking a while to connect all the things I've heard, to know from the winds which way is east, to know the specific sound signature of wind in the pepper tree and the gum tree, to recognize the patterns of unfamiliar birds. I hear the pathways of air travel, weather systems in the making, the direction neighbors travel to what must be a town over the horizon– the great living web of nature and mankind.

Moving outward from the center of my sonic map, I decide to explore to the north. I'm hearing that same roughly paved road from the inside of a speeding car.

My destination is the nearest town along the banks of the Murrumbidgee River, the great water passageway of the Aboriginal peoples who have lived on these lands for 60,000 years.

A back road skirts the town of Narrandera and takes me past ramshackle shacks, past the giant "Water leisure feature" with its squealing kids and ice cream vendors. Everything changes as I enter the protected area along the river, restored by the indigenous Wiradjuree to what it may have been like before first contact with Europeans.

The atmosphere is totally different here. Outside it's an ultra-hot, harsh day but within it is suddenly cool and filtered, breezes sweeping through the stands of giant gum trees. As I go deeper into the vast forest it becomes more and more magical. Green filtered light and ancestral gum trees standing gnarled and tall amongst slender progeny. It is pristine. Elfin. Magic.

> *"It is open sounding for a forest, spacious and generous. I clap—there is a gentle cathedral reverberation with no slap back echoes. It is not as small, soft and diffuse as the reverberations of a pine forest or as tight and closed as the oak and maple forests I know from home. I find this acoustic pleasing and enjoyable. The breezes are a hundred feet high overhead, sweeping through the canopy with that silvery filtered leaf sound peculiar to gum trees. But down here on the forest floor it is open and vibrant sounding. You can hear far in all directions at ground level while the canopy shimmers with wind and insects. The spatiality is intoxicating. A tune wells up in me, seeking a way out, a melody, a rhythm, a feeling, something about early childhood meeting old age. I keep this in my mind's ear while I seek for an instrument, a simple one, to accompany."*

I peel some thick curved sheets of bark from the trunk of a fallen gum. I stretch music wire from end to end and quickly have a crude one-stringed guitar, tuned to the key of the insects. I use it to accompany the song which emerges from a mix of childhood memories, the splashing laughter of children in the river beyond, and the look in baby Holly's eyes as she confronts the fresh world.

> *"Where are you going, if you don't know where you are? I hope you're going far/"*

Day 6: A nearby water hole—In search of the "kinda-blue-bird."

I have fallen in love with a beautiful bird song with long and lonely simple melodies. It sings an octave below the other birds, its low voice reverberating in the schoolyard and trees beyond. It sings "HEY! nonny," wait, wait, wait... "HEY! nonny. It waits, waits, waits, and then lets loose a surprise motif. It reminds me of Miles Davis waiting out his rhythm section then blowing two perfect notes and falling silent. I call it the "kinda blue-bird" in honor of Miles.

After listening from a far for days, the "kinda-blue-bird" and I have an encounter. Out in the far back field near the pond I find a fallen tree with hollow sections. A ready-made

FIGURE 13.2 Odland, veiled against the flies, plays a duet with the "kinda blue-bird" on downed tree slot drum. (Photo by Bruce Odland)

slot drum. I begin to improvise some melodic rhythm patterns, exploring the resonances, when the "kinda blue-bird" joins in, up close, completely in rhythm with my drumming. I change up my rhythm, it echoes the changes and throws back something new—a cross-species duet between the bird and a human emerges. My mind goes blank. There are no wrong notes, no hopes and fears, just this moment suspended in time and the awareness of not being alone, being part of nature. Time stands still while the music goes on. Beauty. And the record light is on.

The "kinda blue-bird" carries its instrument wherever it goes. I try to do the same with my recording gear. And the world resonates with found "instruments" waiting to be played.

Day 7: The Old Birrego School—The ears warn, the eyes confirm.

I wake up hearing that something has changed. The birds are singing different songs. My brain scans memory of places and sonic atmospheres past, looking for a match, a pattern—yes! It sounds like birds before a big rain. The gum trees are bucking and swaying in a building wind. Yes! It sounds like rain. How do I know? On sunny fine hot days the "kinda blue-bird" plays a descending major second "HEY! nonny," waits and repeats. But now it's singing a series of descending scooping thirds, "O you BETter GO inSIDE." The whole schoolyard has the chaotic feel of an ocean liner with people running for the life-boats. As if the birds are singing "get ready, get ready!" All this is clear before I open my eyes. I walk outside. Eyes confirm. Big clouds. Drops of rain splatter on my back.

Yesterday the birds changed their songs in warning But I was busy in headphones recording a duet with the "kinda-blue-bird." I clearly heard the warning calls and ignored them. So I had to scramble for cover and pack my recording while the heavens let loose.

To be warned and to ignore is a common phenomenon worth exploring on a cultural scale. We hear the building storm of noise we ourselves have created in mad pursuit of .... . .of...of what exactly? But we choose to ignore it. Will we get caught in the Big Storm even though we hear it coming? If hearing were believing, probably not. But seeing is believing. And we are blind to our noise.

> *"I hear the jet above me burning fuel, I hear the air pressure system – wind - push a leaf and the tree bend it back with a rustle, I hear the wing of the bird beating air, I hear the internal combustion engines on the road two miles away and the inflated tires spinning on the asphalt as they spin under the pressure and weight of the car. I hear the air vibrating in the bird's throat, beak and body. I hear the vibration of the tall grasses being pushed back and forth against each other in the wind. I hear the beating wings of the fly as it passes near my ear, I hear the fluctuating sounds of a jet passing above the masking lens of the clouds, I hear the density of the moisture particles held by the clouds as they deflect the sound of the jets, I hear the creek of the chair as I lean against its back."*

Sound is a direct readout of all the vibrations around me, of all the energy being expended at that moment. It is an information-rich real-time hologram that can be decoded by listening and pondering.

Day 9: The Strong's Farm—The ears inform.

This land is harsh. There are obvious dangers—brush fires burning hot and fast through miles of tall wheat fields—and hidden dangers as well—poison snakes in the grass, snags in the water hole, bindi thorns in your socks. My hosts at the Old Birrego Schoolhouse, Vic, Sarah and their daughter baby Holly are newly arrived from the coast. They are very lucky to have experienced neighbors, the Strong family who has worked the land that surrounds the school grounds for generations.

Garth and Jan Strong tell us about their connection to the land and its sounds. They anticipate the direction and severity of approaching storms by listening to the outlying buildings and trees. The wind in a certain tree alerts Jan to a coming Nor'easter that lashes the buildings with heavy rains. Garth knows wind is from the southwest when it flaps a bit of tin on a shed. He'd like to fix the flap, but leaves it as a warning sound. The chickens have a special alarm clucking when they see an eagle overhead. The pigeons in the yard have different alarm cries for danger from the sky and ground. The powerful harvester machine makes all kinds of sounds and vibrations that foreshadow mechanical problems.

FIGURE 13.3 Morning birdsong predicted this gathering storm hours in advance. (Photo by Bruce Odland)

A good ear can save on expensive downtime from breakdowns and fires. The sheep, normally quiet, bleat when the lambs come. Garth and Jan don't consider these observations special. They are ingrained, just part of living on the farm.

Day 12: How to save $100,000 on sensors (or how to open a window and listen).

I wake to the sounds of heavy wind tearing at the tin roof and lie in bed listening to the sugar gums toss and turn. I fear it may rain, but then I hear the "kinda-blue-bird's" sunny day song and I relax. I'm trusting in this newly developed sense of hearing a place. Yesterday when we left at dawn amidst big clouds I *knew* that I did not have to bring a rain jacket—the birds were not signing their rain song. I've been listening full time, learning to decode the sound signals that are all around me.

Normally there would be obstacles. In my kitchen at home constant radio voices of NPR would mask the sound of the outside world. The heavy drone of my refrigerator fills all the nooks and crannies of my listening space with a detuned standing wave. Steady waves do two things. They make it impossible to notice the more subtle quiet sounds by covering up the quiet range of hearing. The second is the drone effect. In the hunter-gatherer soundscape where our hearing evolved there are no fixed steady sounds that repeat exactly and endlessly. The stream, the wind, the waterfall, the rain, the sounds of animals insects and humans all fluctuate in response to the time of day, the time of year and all the infinite twists and turns of the weather. The marvelous abilities of human hearing developed to help us perceive our place in this fluctuating world. There is nothing like the hum

of a refrigerator to short-circuit these delicate perceptions. Nothing like an air conditioner to shut them out completely.

But here at the Old Birrego School there are no droning standing waves so the whole subtle world of listening has been opening to me like a flower. The process feels rich, tasty, like a good meal. The practice of sitting under this gum tree (which locals call the wind harp) gives me a reference point and let's me compare the days, the shifts of weather and wind, the changes of pattern and acoustical perceptions about of the world.

There is another thing that interferes with the attention needed for listening out into the world. The iPad. The gorgeous little computer I'm using to write this steals my attention away from listening and brings my circle of hearing down to a very small point. In fact it vanishes down the vortex of a myriad of online possibilities. My imagination goes online and leaves me behind. I'm not really here. I'm in hyperspace.

> *"I make an effort and pull my imagination out of hyper-space, shift back out into the world around, and hear the wind tip over a bucket near the kitchen, hear the plastic bottle blow across the yard, hear the sway of gum tree branches high overhead, the rattling approach of a distant empty grain truck—I'm back."*

But if you are driving an industrial scale combine harvester through fields of wheat sealed in an air-conditioned cab watching a DVD while a satellite autopilot drives your rig, then where is your attention going? Garth Strong told us about the need to listen to your machine, know its vibrations to avoid danger, breakdowns, and meltdown fire. We heard the story of a low-wage laborer taking his hands off the wheel of the giant machine and zoning out in the cab while the satellite robot harvested grain. The next thing he knew he was staring at the sky after the half million-dollar rig hit an uncharted tree. The standard solution, and it's a good one for the bankers, is to replace our naturally given sense of hearing with a hundred thousand dollars worth of sensors.

Or we could just open the window a crack and listen.

Epilogue

Over the three weeks of my residency, I learn how to orient myself to the sounds of the land, how to tell the weather from the birds, how to identify the weight of a grain truck by its sound on the road. I feel I have reclaimed some very basic hunter-gatherer listening skills. I have created a sonic map of the world around me. My sphere of hearing has stretched outwards for miles. It's a readout of the entire world around me in real-time. I go on to build an orchestra of instruments from found objects, rooted in local history and local materials. I feel that the whole world around me is vibrating with information just waiting for me to listen. I have re-learned to revel in the beauty of listening.

The challenge, then, will be to take these enhanced skills with me back into the modern soundscape of industrial sounds, an accidental soundscape built without regard to human scale or human perception. I will try to use what I have learned to decode the sound of my own culture. For I strongly feel that we will not understand ourselves until we understand our own noise.

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Ximena Alarcón is an environmental sound artist who often works in the space between the experienced environment and virtual environments. She engages in recording migratory spaces comprised of trains, metros, people, languages, accents, and textures and in connecting these sonic experiences to the individual and collective memories of commuters. Her practice involves Deep Listening, sonic improvisation, and networking technologies for the expansion of our sense of belonging and identity. Alarcón brings to light the sonic migratory spaces that lie in between departures and destinations, searching for a holistic way of being in the world.

Since 2011 Alarcón has been a Research Fellow at Creative Research in Sound Arts Practice (CRiSAP), LCC–University of the Arts London. She has a PhD in Music, Technology and Innovation from De Montfort University and received a Leverhulme Early Career Fellowship (2007–2009).

14

Sonic Migrations

Listening in-between, sensing place

Migrations

When a known acoustic space drastically changes, as it has been the case of my geographical migrations, memory and senses look for references that help to accept and understand a new place, and its implications for the perception of personal and collective spaces.

In my first migration to Europe I found myself more attentive to the urban sound that surrounded me. Trains and metros particularly were new exciting guides to take me into unknown destinations, transforming my perception of time and space with their machinery rhythms, sound gestures and textures. I also gained awareness of the diversity of the sound of people's voices, languages and accents, and of the sound of my own voice: the changes in its accent, strength and pitch.

After years of living away from my native land, and reflecting on research around the crucial role of sound to inform people's sense of place, I have understood that the acoustic environment is not something external to me. In fact, in order to inform my subjective sonic perception, I assume the environment as the negotiation one makes between the outer space and the self: thoughts, sensations, and feelings. The resulting connections and combinations are what define a sonic environment.

To make such negotiations, I have chosen listening as my main practice, combined with the use of networking technologies. In the last six years, I have worked specifically with Pauline Oliveros' Deep Listening. This practice invites me to expand my awareness of inner and outer sonic spaces, which transcend time and space. For instance, memories of sounds that used to inform my daily life in my native country become resonant in my mind; if I decide to bring them in my awareness, these continue being part of my sonic universe. This universe overlaps with the new space where I live, and the feelings associated to it; my whole sonic universe expands and therefore my "sense of place." Thus,

I have been in a quest for forms that help and reflect on how I could inhabit multiple spaces.

I have found expression in sound, improvisatory performance, together with Internet technologies, to make audible the individual and collective negotiations and connections between spaces. My major works, which I will describe later in this chapter, have involved participation of people in listening experiences and improvisatory mediated performances reflecting on their inner and outer sonic environments. Their inner environment includes memories informed by acoustic accumulated experience, and triggered by sound perceived as a present event. Following a process of listening and remembering, and mediated by technology, I am interested in creating frameworks that aid individual and collective expressions for the emergence of narratives of interstitial spaces.

Sounding Underground

In *Sounding Underground*, an online interactive sonic environment, I linked together three underground transport systems through commuters' memories of soundscape in the metros of London, Paris and Mexico City. To develop this work I took as a departure the impressions that the *outer* sonic environment creates in people while commuting in the metro, and the memories and feelings that it produces.

Mobility in cities through this powerful urban infrastructure could be understood as everyday sonic improvisations within a pre-determined destination and routine. After having conducted in-depth interviews with commuters about their memories in the metro, I asked each participant in the project to record a journey. This recording did not involve questions; the focus was on their listening and the ways in which each of them decide to live that journey (e.g. in silence or talking to other passengers or to me). The intention of listening immersed twenty-four participants in London, sixteen in Mexico City and sixteen in Paris, in a dynamic interaction with the complex sonic world composed by people, machinery, reverberant acoustics, and in a ritual of going underground. The body is part of the ritual: trains and escalators carry people temporarily, becoming part of their movements and feelings, which also are influenced by the crowd and the architecture, defining the ways in which each commuter marks the space.

The journey immersed them in a deep reflection on life. Alvaro Itzamá, a participant from Mexico wrote about his experience in the *Sounding Underground* blog:

> Also there are voices and metal growls, perfumes, and strange scents, expensive or of extravagant origin. One reads, another laughs in a forceful way and looks around as anyone would, curious and clumsy in the maze. The carriage of the Metro is a living parable of an Island: you find the hero, the hopeless lady, the mother, the grandfather: this is a lottery where everyone plays a role. I also find a mad man. He speaks alone, curses, gnashes his teeth, and looks around. He owns

> his continued freedom and swaying movement. He is aware of his environment and his words. He knows who he is, but I walked away before any unannounced disaster. Three, four, five more stations and the population decreases, the heat in the bloated carriage gradually dissolves. Music sellers begin their shouting, giving life to this chaotic journey, giving rhythm to the movement of the train.

After listening to the recordings, participants selected meaningful fragments of sound, which were between 15" and 1'30" long. These recordings were organized on a graphic interface, created according to the space in which the recording took place, the type of sound, or their poetic imagination.

These spaces were my basis to imagine a virtual space with connections, departures and destinations, challenging known cartographic ideas of underground transportation, and going further than a psychogeography exercise. From my perspective, interstitial sonic spaces should not be mapped, as maps denote boundaries. My intention with this work was not directly to transgress the space, but to focus on a routine by listening, letting oneself fall into surprise by synchronicities, leading to a reflection on relationships of inner life and the outer sonic space.

The underground sound environment, my departure, understood as *outer* is now virtual and interrelated; the familiar made unfamiliar in an Internet-based space. Connections between the three cities create sonic spaces where the rhythms, sound textures and gestures are together in a sort of interactive collage that invites people to find connections and open their imaginations for the depth of the meanings and feelings that arise from a shared urban underground infrastructure.

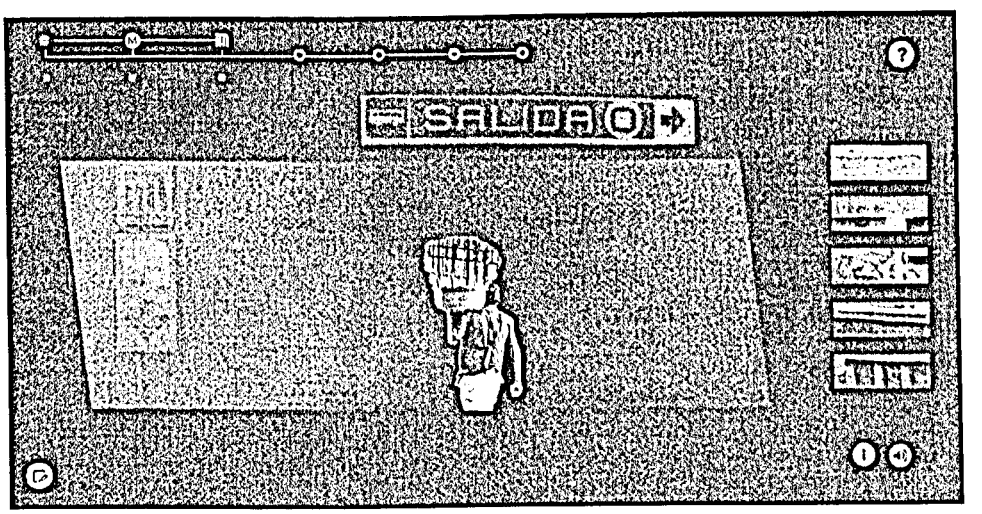


FIGURE 14.1 Entrance to Mexico in Online Environment *Sounding Underground.*

In *Sounding Underground*, each metro stands out in its uniqueness because of the connections with the others; each metro is a passage to arrive to the other, within the other. Each virtual journey immerses the listener in an *inner* journey to their underground imagination:

> "Some days I generate another attention 'prayer' for the vicar in me to attend to later." Andrew (London) June 29th, 2014
>
> "The underground sound is like the one of the TV when there are no programmes or the one of the swimming pool—it makes me sleep. Hello? It is so nice to listen to familiar backgrounds in the wrong place." (London, August 2005)
>
> "underground from the city-ground, nowhere near an underground except quiet pine needles. How long to connect between stations? how long this world ..." Inya (Durham, Ontario—Canada, March 15th, 2010)

I am interested in hearing sound as it crosses boundaries and creates unexpected environments: not fixed or protected. I perceive these as cultural transformative environments that immerse listeners into the feeling of multiplicity and challenges pre-determine ways of listening and being.

Listening and Remembering—Networked Improvisation for Four Commuters

As part of the fieldwork to create *Sounding Underground*, participants engaged in a co-located networked improvisation, which I called *Listening and Remembering*. Four participants per session were invited to listen to a metro journey, created by the excerpts of metro journeys of all participants in the research. The sound was spatialised using five loudspeakers. Each participant had access to a computer and a microphone. Every time they felt a memory has been triggered by a sound, they voiced it and recorded it, making it available in a play list for all the other participants.

Any participant was able to playback others' sounds, opening opportunities to freely communicate any memory and if wished, to create monologues or dialogues, while amplifying others' voices and their own.

The re-created *environment* with the use of technology mediates the relationship between people, and their memory of the metro space. These narratives challenge individual recollections of sound space and invite to create collective negotiations about feelings and understandings of a shared space: a collective memory.

In this dynamic, as I explained in a related article called *Listening and Remembering: Networked off-line improvisation for four commuters*, participants created three forms of interacting with the sonic space: *real space* (as if they were in the metro), a personal

FIGURE 14.2 *Listening and Remembering*, co-located improvisatory performance for four commuters, Paris, 2009. (Video frame by Wilfrid Massamba)

memory space (the memories they shared with their voices), and a *performance space* (where the metro is perceived as a background space to develop any kind of sonic intervention). Engaged in the ideas of Alvaro Barbosa, I considered these spaces as *shared sonic environments* that link together the experience of this particular acoustic community, in what James Wertsch calls a collective act of *remembering*.

This sonic experiment offered a co-located offline model structure to be implemented online. Thus, it was opening the possibilities of thinking telematic improvisatory sonic performance and its possible dynamics, which I next developed in the subsequent project *Networked Migrations*.

Networked Migrations: Listening to and Performing the In-Between Space

When engaging in Pauline Oliveros' Deep Listening practice, I focused on listening to my own migration: the sound spaces in-between geographies and cultures—which are embodied and resonating in my mind—as well as their overlapping with physical present spaces. In the mixture, I experienced how the spaces expand through body, memory and imagination, thus opening alternatives to feel a sense of place in a foreign land.

Experimenting with a Deep Listening study group, the *Migratory Band*, I engaged them in a series of scores to improvise with sounds and gestures that involve distant spaces, and experienced how our feelings can be transformed by the reenacted memory of those in our present physical environments. This experience was the ground for the creation of *Networked Migrations*: a series of real time improvisatory telematic sonic performances exploring the in between space, between people who are in distant locations, and share the experience of migration. The actual feeling of distance, and the connection established with technology strengthens the metaphors involved in the experience of migration. In this case, the sonic environment linked to a particular place, although included in the memories and contexts, was no longer the center of attention.

In *Letters and Bridges*, performance between Leicester and Mexico City, participants used spoken word, based on letters that they had from beloved ones, and wrote new letters to their performance partner, about the feelings towards the place where they live. They combined contexts, feelings, languages, and traveled with their words to each location included in the performance, and also to remote locations included in their letters. They were crossing bridges that allowed them to be in contact with those memories supported by someone else in the distance. They created together another space that was detached from their original writings. This space was considered as a bridge that expands their imagination and sense of place.

In *Migratory Dreams*, performance between London and Bogotá, participants who were all Colombians, reflected on their night dreams, as part of the process of deep listening, and gained awareness about the spaces that came alive in the dream space, relating these to their migratory condition. Each participant wrote a dream, which during the performance was amplified by the other participants, as a way of including them as part of the dreamer's dream. The process of amplification brought an intimate sharing of feelings of migration for people who have a common mental territory such as Colombia. This environment was still resonating in the memory of the ones who were in London, and was amplified by the ones who were in Bogotá, who paradoxically, at the same time, brought distant locations from the world, such as Italy, Japan, France, and a very intimate space such as the woman's womb. In London, participants brought family and street spaces that are located in Colombia and London. The complexity of environments created here, because of the narratives but also because of the inclusion of pre-recorded material, which cannot relate to a specific environment but to a feeling, invites to reflect on the porous nature of in-between sonic migratory environments: memories and sounds move between mental dream space and physical awakening spaces, transcending physical and mental borders.

Technology helps the flow between the distant locations adding its own sonic elements and influencing the way in which each group of participants listens and creates their own environment.

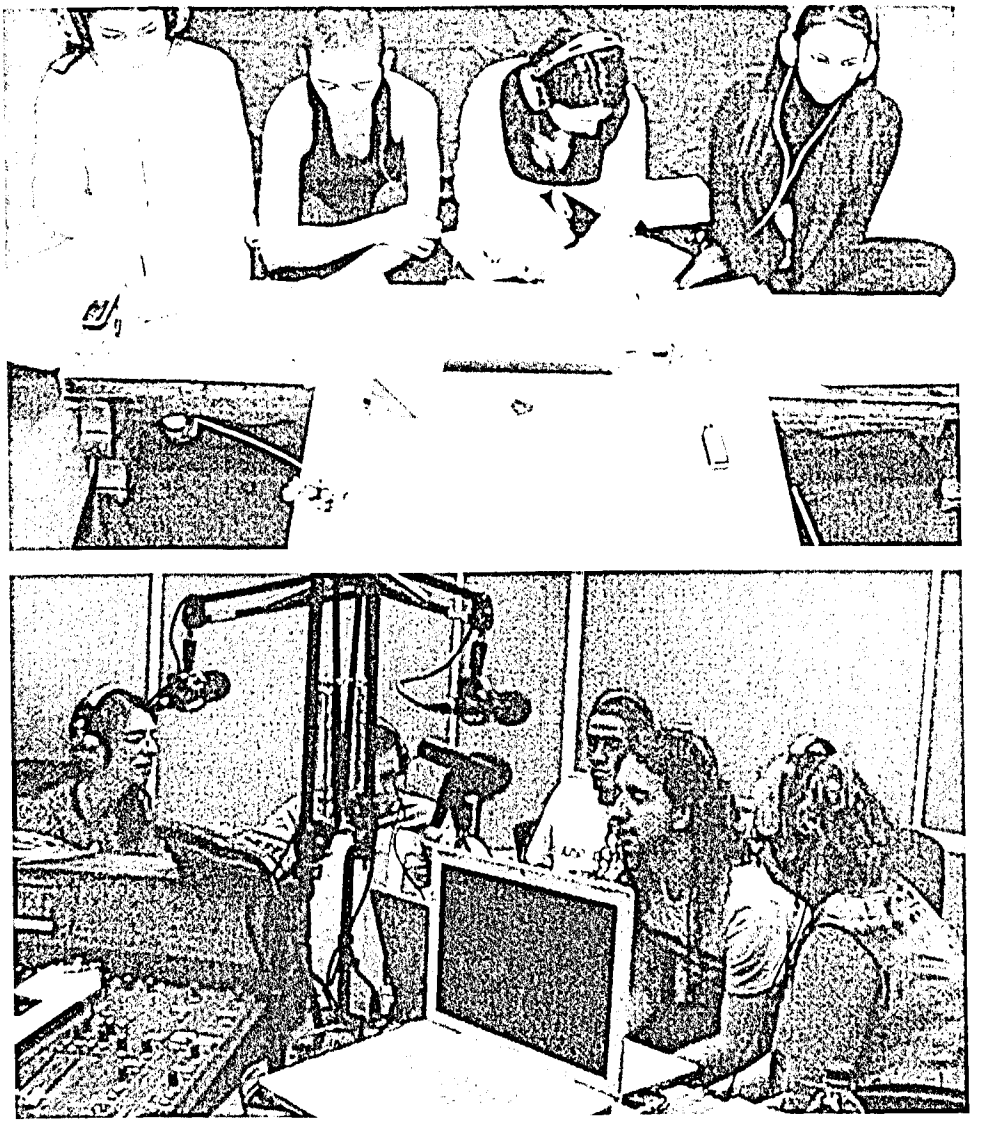


FIGURE 14.3 *Migratory Dreams*, telematic performance between London (top) and Bogotá (bottom), August 3, 2012. (Video frames by Sandra Miranda Pattin and David Agudelo Bernal)

Questions of embodiment and voice being heard in the distant territory without visual references is an interesting experience in these telematic works that invites to think of sonic environment as one shaped by voices expressing from multiple territories, as if these could create landforms broken by gaps in languages and broken by the natural unstable spaces of distant communication: making valleys when there is a quiet agreement perceived in their voices, and making mountains and volcanoes when explosions of laughter come together during an improvisatory performance.

Final Reflection

My approach to sonic environment has evolved since the initial approach to underground commuting environments, which allowed me to create *Sounding Underground.* I perceive the process as born in the intimacy of listening to one's own journey and empowered with technological infrastructure that is part of a routine environment. The power of the *outer* environment, in this case, the metro, brings the *inner* experience in a special unique condition to find introspection and it is being enveloped by memories:

> I loved your *Sounding Underground* site—how evocative sounds are. I grew up in London and used the Underground a lot: it was a normal part of our lives. As such we took it completely for granted, and it's so interesting to see it treated in the way that you have done. (Joanna Horward)

> From a while ago I've been exploring your spectacular work... with some interruptions. I've explored step by step... and every time I discover more details and interesting things... my feelings at the moment are about transportation to unknown places and the feeling that in each place, according to its culture and the different cities, people live in a different manner...feel in a different manner... face up life in a different manner .... (Maria Gabriela Alarcón)

> I checked the web about your project that I found it very interesting, in particular the alive reflections of what people feel when they are listening to the journey in the metro. The interrelation between them too. I like it because it's on the boundary between sonic intervention and performance (by non-musicians). A very nice project. (Carole Changerón)

Combining the virtual environment with creative forms of sharing reflections and memories within a process of listening becomes the basis for the subsequent performances which depart from the experience with environment but become more and more attached to the experience of the voice.

The perception of an environment for me becomes abstracted from the journeys and in the case of Marie Christine Camus, a performer in *Letters and Bridges*, it moves directly to the migratory experience, stating a detachment from specific geographical sonic territories.

> I liked the idea of networking, opening multiple options... it was new to me, to explore with voice, and made me enthusiastic in continuing exploring these practices. I liked the final result, which had humor, poetry, sadness and happiness. (...) Sometimes something happened, and I thought there were the bridges that were created: an ephemeral encounter through concept, body (voice) and technology. (...) It was a collective experience and that, creates 'displacement'

Networking technologies, bi-directionality of sound streaming, and the experience of real time, connote in my work an evolution of the ways in which we listen and influence each other's environments, and the way in which we reenact memories and create narratives. To understand my work, it is necessary to deconstruct it, and take each aspect as a nourishing element that leads to another and builds an iterative process: a personal one, a collective one with participants, collaborators and audiences, together with the careful appropriation of chosen networking technologies.

It is the porous feeling experienced when listening to the three underground environments at once, in an online interface; when interacting in a co-located improvisation; and when improvising in the *Networked Migrations* telematic performances, what inspires me to acknowledge the existence of multiple sonic words which are actually heard as part of a human condition of multiplicity. These assert the cultural importance of acknowledging expansive and complex sonic environments that challenge the perception of ourselves within cultural diversities.

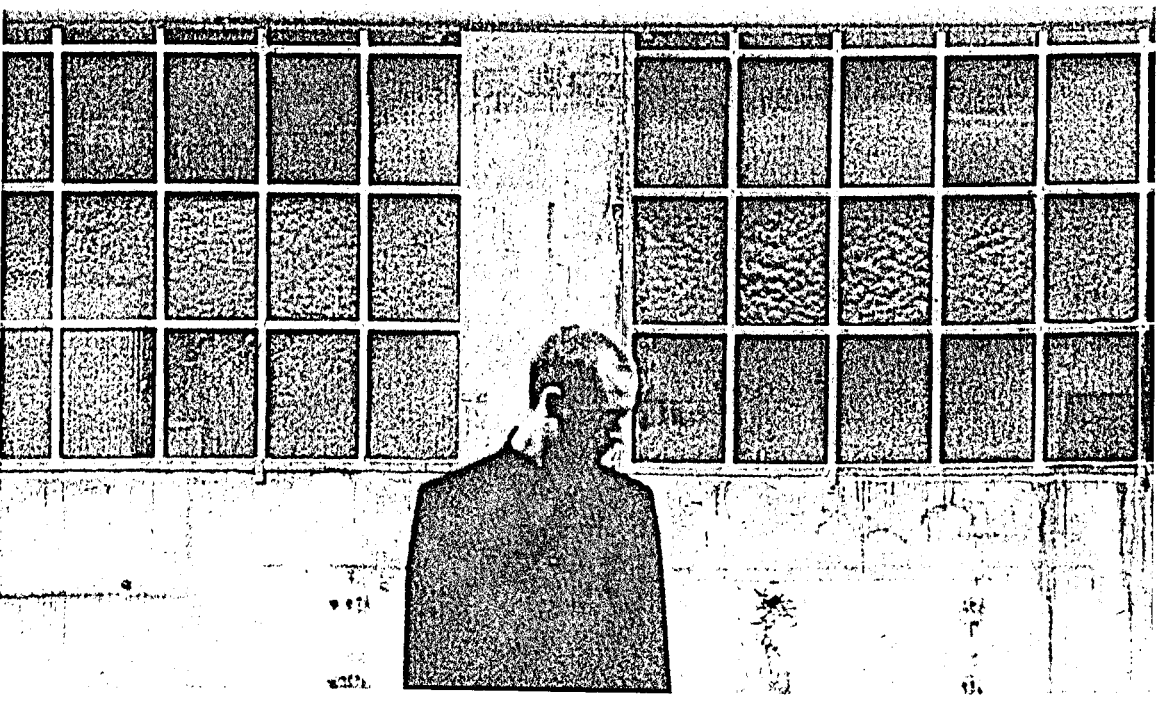


Photo Zimoun

Zimoun is a Swiss artist who lives and works in Bern, Switzerland. A self-taught artist, he is best known for his sound sculptures, sound architectures, and installation art that combine raw, industrial materials such as cardboard boxes, plastic bags, or old furniture with mechanical elements such as dc motors, wires, microphones, speakers, and ventilators. His sculptures reference the chaos of the modern day while retaining an order of minimalism. Zimoun's work strikes a natural balance between the use of simple and easily comprehensible materials and the complexity of the patterns and textures that result when these materials are put into motion by low-tech means. Like the chaotic forces at work in the environment, his works evolve and seemingly come to life through indeterminate processes and chance. Zimoun is an artist with keen observational skills and a significant imagination. His work has been presented in solo and group shows as well as performances internationally, and he has been awarded various art prizes and residencies.

15

Sound Architecture

With a sensitivity to location and rhythmic potential, I produce works that evoke control, perception, absence, and nature. Often highly ordered systems of movement are derived from simple and low-tech means. The projects can somehow be compared with mathematical formulas or a science experiment, as I deploy wit and a keen observation of space and sound.

One of the key elements of my practice is the study of vibrational microstructures. The work explores the mechanical rhythm and flow of prepared systems. Both sonically and visually, units of pulsing activity form the basis of the compositions, whose timing and contours are determined site- specifically. Blank zones of play are constructed, and set into motion by the elements of gravity, resistance, chance, and repetition. In my sculptures and installations, scale becomes a tool of amplification or visual multiplication, as I adapt each system to a particular context.

What I call *sound architecture* signifies a space of entrance, but also a sound composition that functions more like an organism, something that is not changing into something else overtime, but rather full of variations in its details and potent in its sonic possibilities. It's not about a beginning oran end, it could even be endless. It's not narrative. It's not going somewhere and not coming from anywhere—even if it is continuously changing in its microstructures. It is more about creating a situation and focusing on the vibrations happening at the current moment. It's about creating a simple system, which then gains dynamism, becoming richer in its behavior.

In my work you hear what you see and you see what you hear. I'm interested in this directness. The sounds are generated in real time, through the combination and physical interplay of materials in motion, interacting with the surrounding architecture. All parts and details play an important role in the work. I don't see myself combining things to create an artwork, but rather to set in motion dynamic experiences including various different aspects. It's similar to lighting a sculpture from different perspectives. You might first think you are seeing several sculptures, but in reality all perspectives together

comprise just the one sculpture in front of you. So, you can't say that one specific perspective is more important than any other. They are all integral parts in the puzzle.

I am interested in a selective mix between "living" structures that evolve by chance and/or chain reactions—in contrast to a pre-determined and contained space, in which these events unfold. The composition manifests itself through a deliberate containment and cautious monitoring. Thus, I do not intentionally stage chance factors or generative systems in order to discover unexpected results, but rather I aim to cultivate the vitality of the compositions. I work with simple mechanical systems and materials in search of the point at which entropy introduces chance within defined frameworks.

I don't try to imitate nature but instead to build spatial sound compositions that have a certain vitality. I create sound fields and spaces, which are constantly changing in their microstructures. This process resembles those of the organic structures and forms we find in nature.

I'm interested in simplicity and complexity at the same time: simplicity in the system and complexity in the behavior that develops out of the system. I attempt to construct stadiums in which the materials begin to act individually, taking on their own behavioral characteristics. Materials, resonance properties, proportions, space, strength, and frequencies are some of the key elements in this process.

My work is on one hand very concrete—what you see is what you get: simple mechanical systems in combination with raw materials. On the other hand, my creations carry an abstract dimension. I keep it very reduced and raw, even the titles are just descriptions of the materials used. I connect the works with many things myself, in many different directions. I try to create work, which is able to activate me, to make me thinking about various things and to create connections and associations. In that sense I hope to be able to give this freedom to the audience too. At the same time there are also many aesthetic decisions behind it, based on an interest in raw, unspectacular materials and the beauty of simplicity.

I see links to various themes and I create the work based on a large field of interests. Perception, systems, individuality, space, absurdity, architecture, science, sound, methods, simplicity, composition, sculpture, nature, minimalism, networks...just to mention a few, or even societies, or industrialism, humor or quantum mechanics...For me there is not one correct link, nor one specific association the visitor of the exhibition *should* make. It is not about being right or wrong. It's great if the visitor becomes animated by the work and starts to think, reflect or wonder, to connect or question. In that sense, the visitor is taking an important role in "finishing" the work.

To develop a site-specific installation it's typically a mix of different elements. It often starts with a specific space that I am invited to activate. I think about the possibilities of how to work within the space, its qualities and difficulties, and what kind of piece would make sense in relation to that particular space. All this while also taking

into account the logistics of the available budget, how much time we have for the set-up and development, as well as the number of available helping hands on site and so on. At the same time, there are always ideas waiting in the pipeline—such as prototypes of systems and concepts we consistently work on in the studio. For example, we thoroughly investigate the possibilities of a specific material; a physical movement; a general system, a behavior; or a sound. The studio is always buzzing with ideas. From this conceptual reservoir, I start to pick out small, single elements that are most interesting to me in relation to the specific situation. Then we begin experimenting and making prototypes. Normally, it takes a large number of prototypes to arrive at a satisfactory endpoint. Each step is vital, evolving one after the other, optimizing performance along the way. Even through serial prototyping, however, totally unexpected results can emerge and influence the entire process. So in the end, there are a multitude of factors, both fixed and indeterminate, that inform the development of a specific piece created for a specific environment.

My first permanent installation took place in a former chemical tank. It is one of the most extreme spaces I was ever invited to work with. Having a diameter of 9 meters and a height of 12 meters, the walls are only about 4 to 7 millimeters thick. The weight of it is about 30 tons. The sound properties in this round silo are very impressive. For instance, clapping your hands generates an echo of about 20 seconds. Two people standing

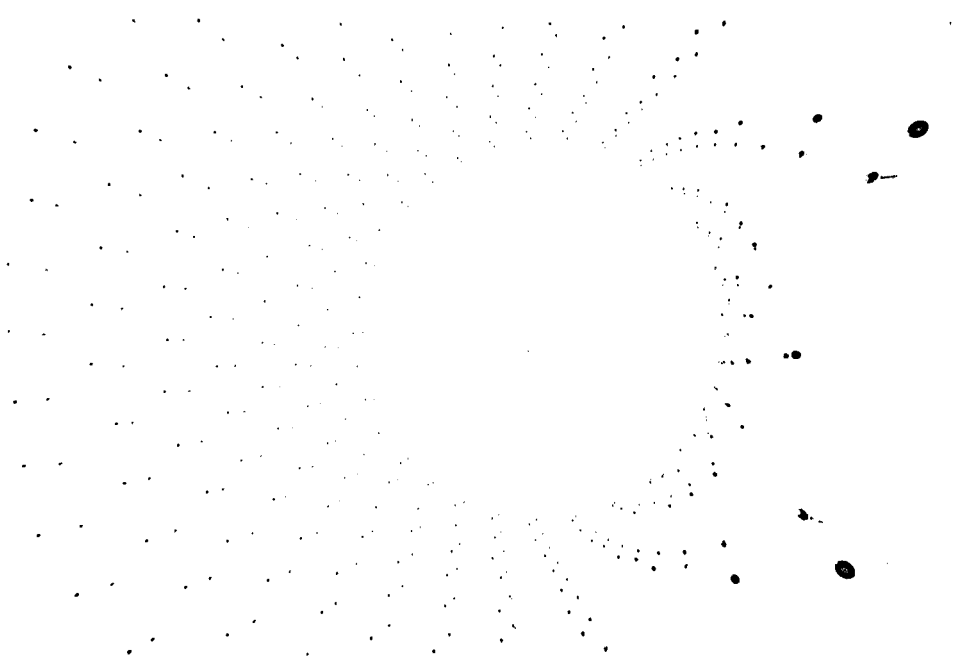


FIGURE 15.1 DC motors, cotton balls, filler wires, power supply, lighting system, bench foundation, toluene tank (1951). (©Zimoun 2013)

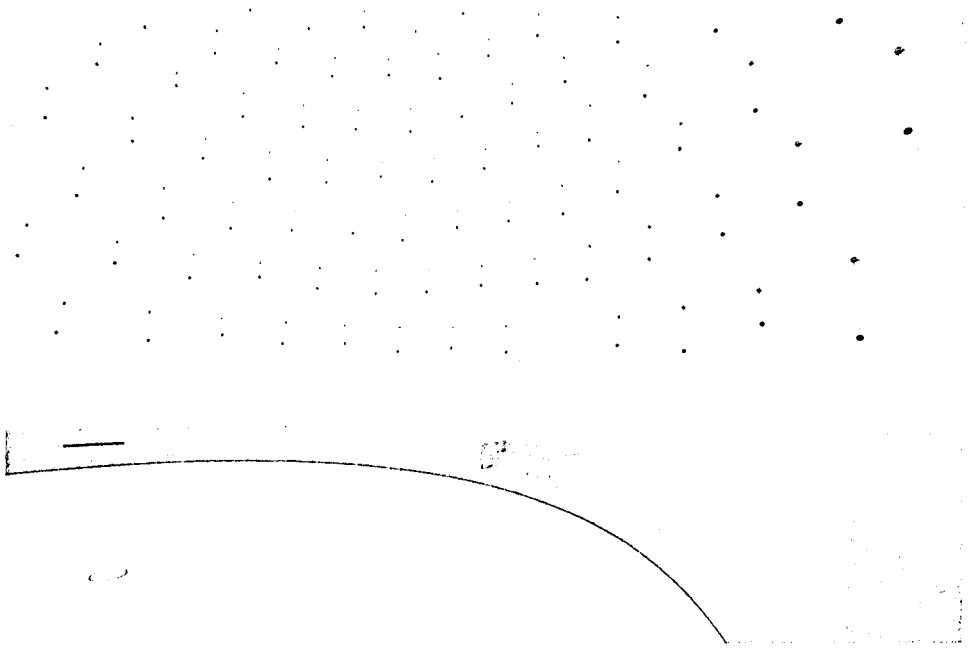


FIGURE 15.2 Three hundred and twenty-nine prepared dc motors, cotton balls, toluene tank. (©Zimoun 2013)

in the silo, but not very close together, are not able to understand each other when speaking, as the entire space starts to resonate immediately. Drumming the walls just with your fists evokes a very engaging low-frequency drone. As the chemical tank (it was originally used to store toluene in it) had to be moved from its original position to a new place, a group of engineers was involved to figure out how that could be accomplished without the risk that the thin walls would just fold like paper. Using a large crane, the 30 ton tank was finally lifted and moved. At its new position, the silo needed a new base to stand on, as well as a door with a few stairs to enter it. For this, I collaborated with architect Hannes Zweifel. I collaborated with Hannes a few times in the past—but never for a permanent work before. Similar to the sound properties of the silo, the *climatic* situation inside the silo is challenging. In the summer, the temperature can rise to eighty degrees Celsius, and cool down in the winter to minus twenty. So there can be a difference in temperature of one hundred degrees. This condition effected the choosing of materials and technical systems.

As it was my first permanent installation, and a huge one, we decided to choose materials to work with that were already familiar to us. We used a mechanical system based on high quality and robust small DC-motors, in combination with filler wire and cotton balls. We installed 329 motors along the tank for drumming it. Each motor is powered with 3 volts DC. So in theory, all the motors would rotate at the same speed. But, the

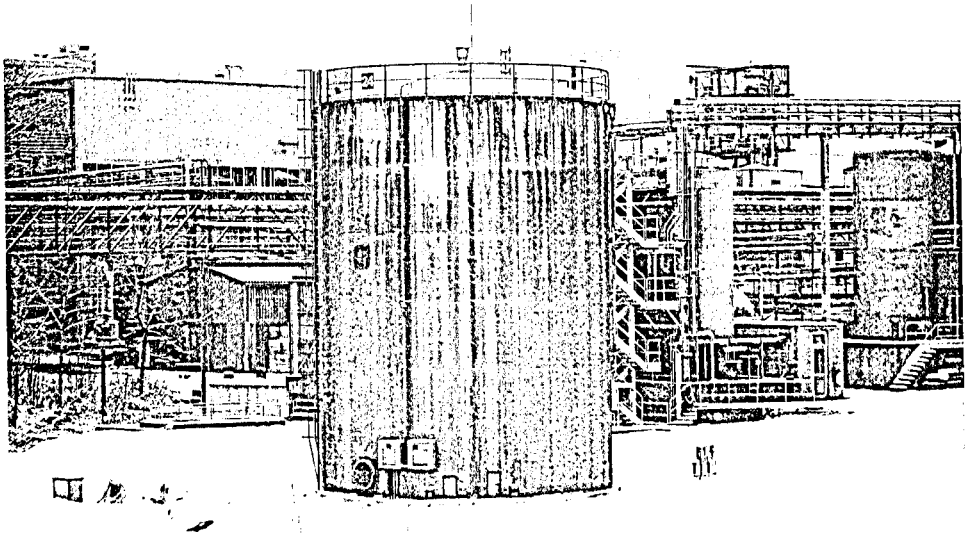
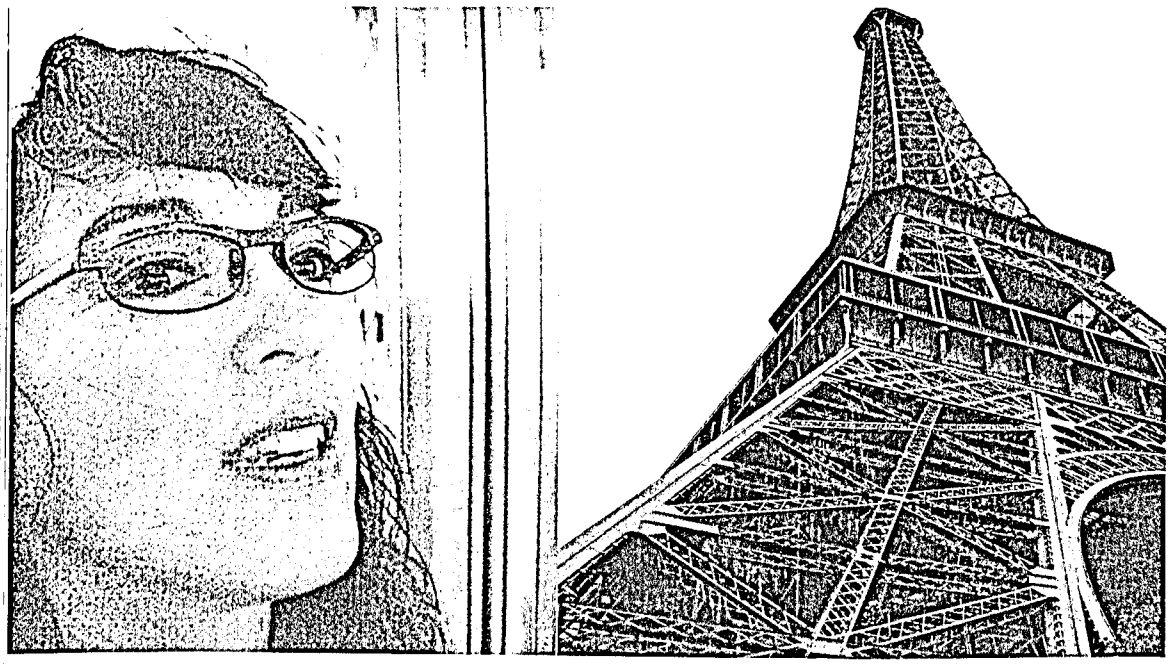


FIGURE 15.3 Dimensions: 9.4 m × 12.8 m height (30.8 ft × 42 ft). Permanent installation located in Dottikon, Switzerland. (©Zimoun 2013)

lengths of the wires, which connect the balls to the motors, are slightly different in lengths. Furthermore, all of the wires are bent a little different, which causes each motor to behave individually. Therefore, you will not experience any of the motors doing exactly the same thing at the same time. That way, the behavior of the entire system evolves with a beautiful complexity related to the generated microstructures in sound and motion. Non-repeating microstructures are being created, both sonically and visually. The sonic and visual complexity is the result of a system that is inherently very simple.



China Blue is an artist of great breadth and depth. Her work explores the inner world of the mind and how technology can be used to extend our perceptual senses. Her work is sonically engaging and endowed with metaphors and questions that challenge the observer on many intellectual and cognitive levels. Her work reveals the hidden structures in our world and inspires us to think. In this artistic pursuit, China Blue incorporates bioacoustics, sonification, ultra- and infrasonic sampling devices, brainwave monitoring, and robotic sensory avatars. She was the first person to record the Eiffel Tower, NASA's Vertical Gun, and represented the United States at OPEN XI, Venice, Italy, and the Tokyo Experimental Art Festival. She is a two-time NASA/RI Space Grant recipient and a RISCA Fellowship recipient and is the founder of The Engine Institute.

16

The Sonic Ecology of Structures

I am fascinated by the hidden acoustics of our world, whether embedded in the iron of the Eiffel Tower or submerged in Venice's rising waters. The underlying theme of my work is revealing the hidden vibratory structures of our world and how they shape our lives.

Our world is filled with and shaped by sounds, both those that we hear and many more beyond the range of human hearing. This ongoing symphony of sonic events drives our attention, our emotions and colors all our other perceptions all of the time, from waking in the morning to deepest night, and is even present and affecting us while we sleep. Sounds alert us when we hear our name called, put us to sleep with lullabies, or scare us with the sudden screech of car tires or our child's cry. While we may think of the world visually, with color shape and size informing us what or where something is, sound, invisible but pervasive, tells us *something happened* and actively directs our attention to let us choose our next action. Sound is thus our most critical tool for providing us with rapid conscious, subconscious and emotional insights into our environment, even in the dark and out of sight. This makes sound our most *personal* environmental cue.

As a fast sensory system, hearing works faster than any other sense. Hearing is our alarm system. It warns us of impending danger by providing an alert to the approaching train, or prepares us to engage socially as we hear the voices of approaching friends. This high speed sensory processing helps us to define a personal experiential timeline that we build moment-by-moment and day-by-day. It is also unique to each person that hears it based on their age, gender, culture, and the location in which it is heard. Because of this, sounds will never be heard the same way twice, even if a sound is repeated. Each time it is heard, even if the context is changed, it becomes more meaningful and sticky, letting us cement memories of experiences and events, turning transient sounds into a history. Sound and hearing create a personal timeline, dependent on space, time and interactions with events, but unique to each person that hears it not only by where, when and what, but by their age, gender and culture. Thus, hearing shapes our world, taking the interactions between matter and energy and creating an individual acoustic ecology.

But, when people talk about the ecology and environment, they usually think of *natural* objects and forces that exist apart from those created by humans—air, water, weather, rocks, landscapes, and other living things. But humans are part of the natural environment, even though more often than not we overwhelm non-human environmental sounds with our own noise, either deliberately through speech and music, or parasitically through construction noise, the low fidelity hum of urban streets or the undersea throbbing of ships. All these sounds, natural or human in origin, dependent on the medium, whether air, water or steel, to propagate, shaped by the physical space in which it travels and are fine tuned by the personal demographics of hearing, making sound central to an experiential environment. This idea of an experiential interactive auditory environment is of particular interest to me and has led me to my many investigations into how sound defines and is defined by architectural space while influencing our individualized perception of it.

For the past 20 years I have been working with sound. As a trained sculptor, I gravitated to it based on a definition of sound that I once heard which was *sound is energy made physical.* When hearing that statement I realized that there wasn't a more elemental material to work with than sound, the result of primordial interaction between matter and energy, neither of which can be created or destroyed, only reshaped. This is the same paradigm used in physical sculpture. No matter the materials used—steel, wood, glass, paper or ceramics—their ultimate form emerges from interactions of energy and matter in the shape of vibration and the dynamics of three dimensional space.

An early work that I often think of (and one that might be the first three dimensional art work that highlights sound as a central topic) is Duchamp's *With Hidden Noise.* In this work, sound articulated the negative space or the interior defined by the core of the string of twine and the two sheets of brass that covered it. The American art curator, Ann Temkin, explains Duchamp's approach:

> For this piece, made on Easter Day 1916, Duchamp set a ball of nautical twine between two brass plates. He then asked his friend and patron Walter Arensberg to place an unknown object inside before he clamped the Readymade shut with four long screws. The title alludes to the rattling sound the hidden object makes when shaken. Duchamp requested that Arensberg never tell him what the secret thing was, preferring to remain blissfully ignorant of his work's 'content.'

Since the production of this work, artistic interest in sound has oddly evolved very slowly over the course of nearly a century. It is only recently that sound has been rediscovered as an art material in its second phase since its formal definition as Sound/Art in 1983.

Focusing on the relationship of sound to energy defines a broad arena of the heard and unheard. When taken out of the theoretical physics context and placed in a physical

space, sound redefines that space in unexpected ways, changing our perception of it. One of the first pieces that I made was *Mikey vs. Fabio*, a recording of a ping pong game between two friends. For this piece I place the microphone above the middle of the table and recorded the hit and bouncing of the balls as well as the dynamic conversation between the two players. Later this piece was shown in a long corridor at Interface, an exhibition space in Dijon, France. There the piece converted a neglected space, a corridor used to transition from the inside of the gallery to the outside, into an experiential environment. The placement of the stereo speakers, widely separated at opposite ends of the hallway, transformed the space from an ignored transit to an acoustically active event. When listeners stood in the middle of the hallway, the space became a playful field driven by the dynamic alternating left/right acoustical pattern. Though the game play was invisible, it immersed the listeners in the actions of the recorded moment and reminds us of Merleau-Ponty's statement from *Phenomenology of Perception,* 1945. "In perception we do not think the object and we do not think ourselves thinking it, we are given over to the object and we merge into this body which is better informed than we are about the world ..."

But my interest goes beyond simple recontextualization of human sounds. In 2008, I was invited to record the Eiffel Tower in Paris, France. There, laden with far too much

FIGURE 16.1 China Blue recording the Eiffel Tower.

equipment and access to restricted non-public areas, I researched the role of the interactions between the ambient human heard sounds and the normally subsonic substrate of the Eiffel Tower. By using geophones (directionally tuned seismic microphones) to record the infrasonic vibrations of the iron of the structure in combination with normal microphones to pick up the ambient human-centric soundscapes, I was able to capture a much broader range of sound than would normally be detectable. From the vibrations of the elevators to the periodic shuddering of the struts in the wind to the tens of thousands of human footsteps that ring the structure, I was able to capture the forces acting on the 2,500,000 rivets and 18,028 pieces of iron that make up the 300 meter Tower, and translate them all into the human auditory range. This let me sample not only the physical impact of the structure, but also the social impact of the humans that flock to see it. The Eiffel Tower has the characteristic of a living fluxing organism... comprised of complex social and physical sonic characteristics. The human auditory sounds represent the sounds of the world around us based on our own acoustic viewpoint, whereas infrasonic vibrations represent the inherent movement and vibrations of the structure. Together they create an acoustic epiphenomenon, an energetic ecology based on time, human presence, and vibrational acoustics—a spatio-temporal aesthetic.

In a much more recent piece, *Negative Ellipse*, I investigated the way sounds fill a room, and the space that they define: the negative space of a gallery. *Negative Ellipse* lends an ear to how a Richard Serra *Ellipse* sculpture shapes sound in the enclosed architectural space while unveiling the hidden voice of his sculpture.

Negative Ellipse was initially created by exploration of the acoustics surrounding one of Richard Serra's *Ellipses* housed at DIA Beacon in Beacon, New York. At the time, DIA had four of Serra's monumental *Ellipses* on display. Serra is a minimalist artist who is known for his large-scale steel sculptures. He creates these sculptures out of rolled steel sheets which stand precariously self-supported on what seems like razor thin two inch edges. Reaching about 13 feet tall and filling an area of approximately the same size (for the work I was focused on), his *Ellipses* have a physical experience whose size dwarfs the viewer between its mass and how it fills the gallery's interior spaces, with some forming labyrinthian mazes large enough at some points, for two people to walk through. In addition to creating a space dominated by size and mass, his works also define a space of emotional precariousness, highlighted by the fact that the sculptures have been responsible for one serious injury and one death of installation crewmembers.

I initially was interested in recording a work of Serra's as an investigation into the acoustics defined by the steel, and emotionally motivated by my near-immobilizing fear of the sculptures. In the past, this fear kept me from walking into a room where they are exhibited, despite my fascination with them. I thought that since I had never walked around one of his works completely, or even into a room where they were exhibited, I would discover something about his work that was not evident to me from the distance of the protective

door jamb (the one place Californians know to go when an earthquake—translated to "disaster" in my mind—happens). So I approached the work from the viewpoint of finding its acoustic potential and to establish that my curiosity would overcome my fear.

I began the process by gearing up in the car with in-ear binaural microphones which fit into the ears and create highly personalized recordings from the vantage point of the listener. The microphones were connected to a hand-held DAT (digital audio tape) recorder which I placed in my hand bag. I then proceeded to enter DIA Beacon in stealth mode to begin the recording. As I entered the room where the Serras were on display, I held my breath, hoping not to flee, or worse yet, pass out. At the time, I was unaware that insurance requirements had mandated placing stabilizing pins to secure the sculptures to the footing, thus rendering them "safe." Unassured, I still walked into the room and focused on the one *Ellipse* sculpture in the middle since I knew my attention span would most likely be limited by my fear. I first walked around its periphery then entered the center, (this was a version that did not have a spiral shell-like interior). It was at that moment, when I was standing in the center to capture the acoustics defined by the surrounding steel wall, that the unforeseen occurred. My boyfriend (now husband) was with me. He is an auditory neuroscientist who shares my enthusiasm and fascination with sound, but was less experienced with the rituals of viewing art, particularly one of the cardinal rules of all art museums which is not to touch the art work, no matter how solid it may seem to be. His boredom with the solidity and enthusiasm for the unlocked acoustic potential led him to say "Listen to this!" He ran to one side of the sculpture and kicked it with his foot then he ran to the other side of the *Ellipse* and pounded on that one too to explore the reverberations of the steel. He said something about large-scale standing waves, unaware that my heart felt like it stopped. My knees weakened. I thought white lights would soon follow. Fortunately, the guards came running in to tell him to keep his hands and feet off the art. Nothing catastrophic happened to the sculpture's balance. I survived, but began having doubts about the project or at least including him in further explorations.

The following day, I mustered up my strength to listen to what was recorded. I was privately worried that it was ruined—what was supposed to be a foray into exploration of subtle changes in ambient sound caused by movement of the listener, had been transformed into a forcefully interactive event. Yet, what I discovered surprised me. By using sound editing tools that transformed the pitch and timing of the recordings, I was able to discover unheard structures hidden deep within the recording when the steel was struck—the voice of the vibrating steel and the transformative, normally inaudible reverberations that filled the space around it for seconds after the impact. It was a frighteningly eerie sound, completely inhuman yet strangely organic: the sound of metal, breathing.

Researching sounds heard and unheard in a gallery is one thing, but then creating an art work out of that is another. What turned out to be my first version of the work (of

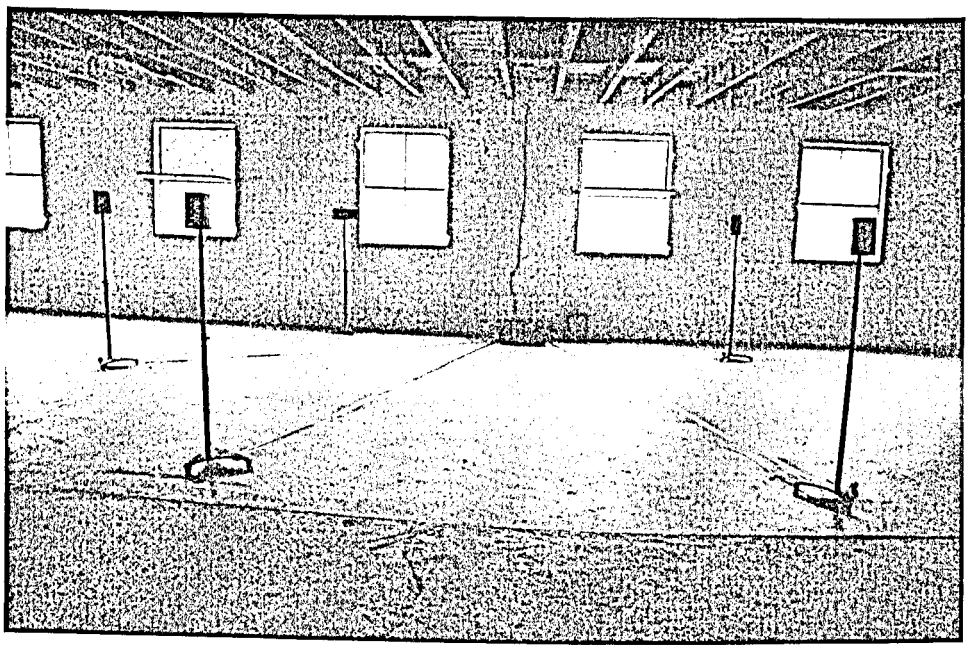


FIGURE 16.2 *Negative Ellipse*, by China Blue, 2013, CR10, Linlithgo, New York.

a total of three) was a scale model I made of the *Ellipse* in corrugated plastic. Inside of the *Ellipse* model I placed two speakers facing inside and two facing out. The two facing inside emitted the sound of the vibrating steel and those facing out played the ambient recording of the gallery space: the call and thrumming of a train going by, the PA system announcing directives to the staff, the sloppy footsteps of a person wearing shoes fitted like flip flops, and the reverberant, incomprehensible, yet clearly human echoes of voices in the distance. This acoustic design, mimicking the spatial environment of the *Ellipse* at DIA Beacon, was presented in 2007 at an exhibition at Galerie Barnoud, in Dijon, France. There, the sculptural object made an acoustic environment that fit the space of the gallery while referencing the source.

But the sound and the piece still haunted me. In 2013 I decided to make a different version for CR10 in Linlithgo, NY. On the bottom floor of the two story building, in an undivided space with long flat areas for sound to propagate through, I placed a 7.1 speaker system in the same layout as the Serra sculptural source. I designed it again with the same acoustic separation, the sounds of the vibrating steel played facing the inside of the 13 foot elliptical layout, now large enough for people to enter, and the ambient sounds toward the outside, filling the large gallery space. As this exhibition space was converted from an old barn with loosely-joined wooden floor boards, the vibrations of the steel were easily carried by the building and the eerie sounds wafted from one floor to the other, filling it with the ghostly metal breath-like sounds.

In this three step process from the initial research, to the sculptural representation at Galerie Barnoud to the space filling sonification of the CR10 version, the massive Serra sculpture was at the center of the exploration of negative space filled with unheard vibrations, waiting for transformation and manipulation. From the raw vibrations in the DIA Beacon gallery to the isolated and scaled down version of the sculptural object deliberately emitting these previously secret sounds to finally, the raw sounds that filled and shaped the space of CR10, the negative space and unheard sounds became the raw materials for matter/energy re-sculpting perception. Investigation of sound for artistic exploration opens up new opportunities to investigate space, time, matter and energy through its vibrations. It provides the opportunity for discovery of hidden or unattended to events that are a fleeting, time based feature, captured by our ears and our attention, to transform basic physics into human emotional experiences that can shape our world.

David Rothenberg is a musician, author, and philosopher. As a jazz clarinetist, Rothenberg jams with birds and crickets and uses rhythmic innovation and improvisation to connect to the natural world. What Rothenberg takes away from the experience is that the birds respond to his music. As an artist, his objective is to change the way we listen. Rothenberg listens to nature and nature listens back. He has a mysterious gift for hearing the birds and the natural sounds around us as music. Rothenberg is involved in a nature-based interactive art that links us to the surrounding world and urges us to participate and pay attention.

David Rothenberg is Professor of Philosophy and Music at the New Jersey Institute of Technology. He is the author of numerous books on music, art, and nature, including *Why Birds Sing, Thousand Mile Song, Survival of the Beautiful,* and *Bug Music.*

17

Why Bring Nature into Your Music?

My name is David Rothenberg and I play music with birds, whales, and bugs. Is this a good way to introduce myself? When most people hear such a thing they think it is a gimmick, and I suppose it is in a way. I find myself known as the guy who makes music with animals. But I take it seriously! I want the sounds of these animals to change my own music. I want to extend our human sense of music so that it includes the beautiful constructions of sounds that animals make. Still, too many people think it's some kind of joke until they hear the music. Then they realize I am serious. Because I leave space for the human and animal sounds to combine. If it works, you will hear the idea I am about to describe without anyone needing to voice it. Though it is a simple one: If we consider animal sounds to be music, they are much more accessible than if they are something like a language.

If we do not know a language, it sounds to us mostly as gibberish, and we look for the translation, the code, the key. But music doesn't work that way. I can get together with a musician from Japan or Bolivia, with whom I don't share a spoken language, and we can immediately start making music together. Human music is like that, some of its meaning transcends all our cultures around some common senses of beat, form, melody, and structure. And even within our own culture, if music proceeds without words we can't really explain or translate what it means. It just must play of its own accord, its own pace, its own shape. Its meaning lies in the terms of music itself, though its effect lies far beyond, into emotion, feeling, pathos and depth. We humans need music, but we can't easily explain how or why.

Can that sense of necessity be expanded into the animal world? Some species are as wrapped up in music as we are, and they sing incessantly long into the days and nights. Animal music is often explained away as something simple: sounds made mostly by males to announce their presence to females, to defend their territory to other males. One approach is to sing alone so as to announce your prowess and superiority. Another is to sing together to create a giant lek of musical desire. Two different kinds of musical strategies

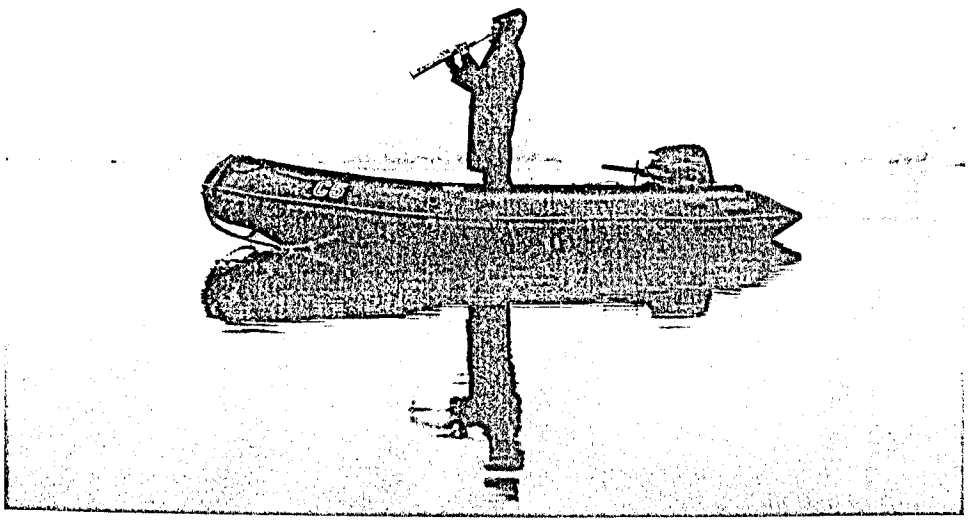


FIGURE 17.1 David Rothenberg in Svalbard. (Photo by Andrea Galvani)

to accomplish the same function. But, the function is not the music: compare a chickadee's *dee dum* two note song with the hour-long aria of a mockingbird or nightingale, or the twenty-four hour song bout of a humpback whale. The purpose of these widely varying musics is supposed to be the same, but the music itself is very different. In people or animals, finding the function does not clarify the essence of the art.

A handful of scientists have tried to study the details of bird song, because birds are important to study because they are among the relatively few species that possess the trait of vocal learning. Only birds, whales, dolphins and humans can learn new sounds as they mature. Intelligent creatures like great apes cannot, which is why we teach them to communicate with sign language and pointing to figures on a matrix board. What ties the brains of vocal learning species together? Many similar structures that other animals do not have. We know more about the zebra finch learning structures than about our own brains, though neuroscientists have found certain similarities in brain structure between us and them. We know more about bird brains than human brains because we have killed a lot more of them in the name of science. Such is just one more way we have perverted animals' lives to our own desires; it is probably more respectful to them to keep them alive and invite them to jam sessions, using music as the most obvious and direct form of interspecies communication, for maybe animals are as confused about what their music means to them as we are about what our music means to us.

In my first forays into this topic, I often chastised scientists for their arrogance. "How dare you call bird sound *music*? That's just human subjectivity clouding your interpretation

of the data." I would counter and say their penchant to count and to enumerate is also another form of human subjectivity. It is easier to lie with numbers than with art. Consider how often one reads in the scientific literature that the male bird with the greater number of syllables in his song, the more complexity, the longer the overall musical output, the more mating success he will have. Makes sense, right? Wouldn't that explain why all this beautiful complexity has evolved? This is the standard story you get in biology textbooks, but it only works in a few species. This, the scientists *don't* tell us. It works in the sedge warbler, but not the great reed warbler, or the European marsh warbler. We don't think it works in that champion singer, the mockingbird. So all that excessive complexity still evolves for a reason we haven't been able to figure out... and science doesn't want to admit that.

But musicians know. And nonmusicians know. The rest of us all know that bird songs are beautiful. "Birds have a natural aesthetic sense," wrote none other than Charles Darwin. "They appreciate beauty. That is why they have beautiful plumage, and beautiful songs." Darwin, that founder of evolutionary biology, knew that beauty is an important part of evolution. Artists, musicians, and all those who are touched by this beauty know that is as objective a part of our world as anything else we care to measure or observe.

By making music along with different species we just might be able to participate in the specific aesthetics of other species. Speaking scientifically, each species that has evolved highly complex behavior through sexual selection, as Darwin posited, has a distinct species aesthetic. There is a certain kind of song that nightingales like most, and this is what has evolved over generations to define the species. There is a certain kind of song that humpback whales like, and their aesthetic involves changing the song en masse as a group from year to year. There are different musical strategies that rival cicada species use to distinguish themselves from each other when they both emerge only every seventeen years: one species merges all their individual songs into a single thrumming drone, while another synchronizes in waves of white noise. Two distinct strategies, musical strategies more than anything else. But it takes a musician to notice that.

With that in mind, I have spent the last five years working together with a team of scientists, led by Ofer Tchernichovski at Hunter College in Manhattan. He is one of few bird song neuroscientists who collected his data not by killing birds and scanning their brains, but by *listening* to all the sounds they make. Ofer has recorded the entire sonic output of baby zebra finches during the three month sensitive period which is the only time in which they can learn to sing—a massive amount of data, more than anyone else has collected of individual birds' sounds. What I have done is encouraged him to take the same data-heavy statistical approach to analyze single, very complex bird songs by the virtuosos in the avian world, nightingales and pied butcherbirds to be specific, to determine if statistical analysis can define musicality.

Our first publication appeared in the *Journal of Hearing Research* in 2014. Such a publication might not be a big deal for a research scientist, but for a musician who began

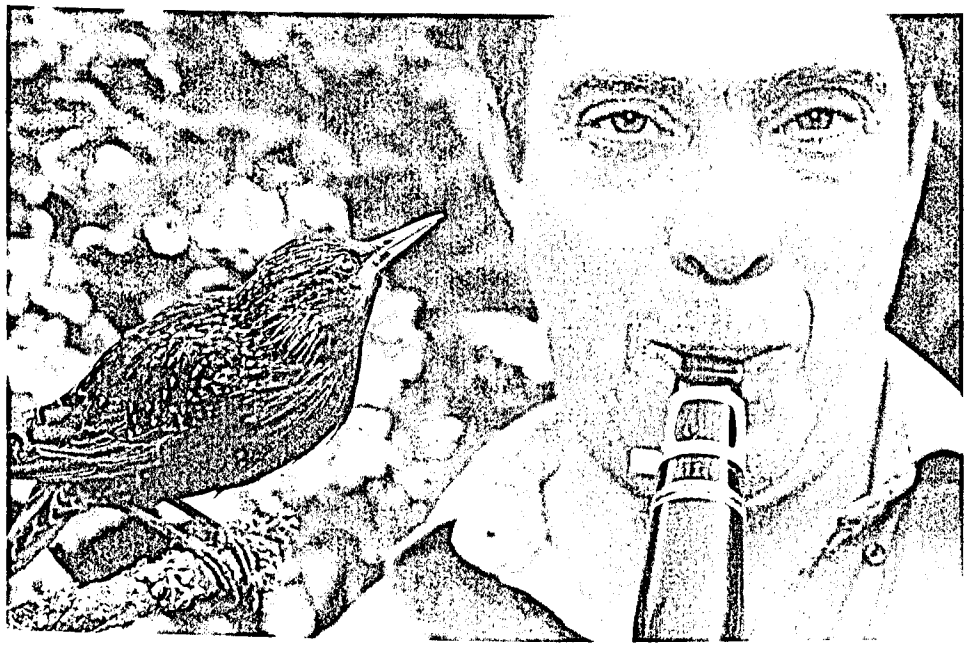


FIGURE 17.2 David Rothenberg and starling. (Courtesy BBC)

his writings on the subject by criticizing the exclusivity of the scientific approach, this is a major step. That kind of work is somewhat the opposite of my intuition, which is to get up and simply jam with other species, because you know the criteria for truth is so different between science and art, this is something that those who wish to cross over sometimes have a hard time understanding. I can play one improbably duet with a humpback whale, where the whale really changes his sound after he hears what I play... that's an incredible feeling, but a scientist will ask: how do you *know* that's what happened? Repeat the experiment a hundred times and then come talk to us. Art doesn't need that kind of confirmation; one interspecies moment of shared new musical beauty can be enough!

In my performances and recordings there is always a mix between carefully produced works that learn from the structures and tonality of animal sounds, juxtaposed with live encounters between humans and animals. These live pieces are in a way the most interesting, because what comes out is so unexpected. But it is always a little stranger than any listeners expect, whether human or nonhuman. Perhaps this is music no one is prepared to like! On the contrary, I feel at its best it extends our sense of what is musical to spread human understanding just a little further into the surrounding world.

Which brings me back to the reaction of the great environmental historian Donald Worster, author of the classic *Nature's Economy*, when he heard my presentation at the Rachel Carson Center in Munich. "Why, David" he gazed carefully at me, "do you insert yourself into the sonic world of these creatures? What are you trying to prove? Are you

trying to give your own work some natural legitimacy?" And I smiled. Perhaps he was on to me.

"Sure, Don, if you call it natural it's supposed to be better, right? Like organic food, hardwood floors, real stone sculptures. I take that idea quite seriously. The music of birds, whales, and especially insects is the oldest music we know, the real classical stuff, millions of years older and millions of years more evolutionarily *correct* than anything a few thousand years of human civilization could be sure of. Nature knows this music is right, for each species that produces it. These sounds have their rightful place the way no human music can ever be certain of."

And here are just three small examples of how a musical approach might change objective knowledge about natural sounds.

First, consider the very first time I played my clarinet with an animal and got a musically interesting response. Back in the year 2000, in the National Aviary in Pittsburgh, at six in the morning, I played along with a white-crested laughing thrush that really started to groove with my tunes. He sang along and interacted, playing a jazzman's game with my licks. There was a real back and forth, not a soloist standing his ground kind of sound. His reaction was more of a true duet, and a musical one at that. You can watch this duet on YouTube and by now plenty of others have done so too. A little bit of perusing scientific papers on this bird's song, of which there are only two, explained that this bird was up to something quite different—in this species, males and females both get to sing, an elaborate and highly musical duet, with each species singing very specific and complementary tunes. This male was alone, and I had stumbled into a music-minus-one situation where my part was honestly needed, as this male had spent far too much time in captivity alone. Most duetting birds sing very simple stylized phrases where the male sings half and the female the other half, but this bird had evolved a wider aesthetic of complex two part music, making it the ideal species to make music with. There is no more interactive complex singer around. And hardly anyone has deemed this phenomenon interesting enough for a scientific study. But one casual walk with an instrument through his home and the potential for a whole science of laughing thrush duets suddenly appeared.

Then think of the seventeen-year cicada... This animal has one of the longest, greatest "beats" in nature. They appear, with exact regularity, only once every seventeen years in any given location. It is so astounding that their scientific name is *Magicicada*. The little critters are actually alive underground, slowly sipping on the fluids from the roots of trees until they emerge like a super-slow click track precisely once every seventeen years to sing, fly, mate, and die. And when they are out you can't miss them. There are millions of them per acre, three related species, and each using a different musical strategy to distinguish themselves from the others.

For many years we have known that only the males make the characteristic cicada buzz and thrum, inciting the females to mate as if in the middle of a giant dance club. At least that's what science thought until two very diligent scientists, David Marshall and

FIGURE 17.3 David Rothenberg covered in 13-year cicadas. (Photo by Charles Lindsay)

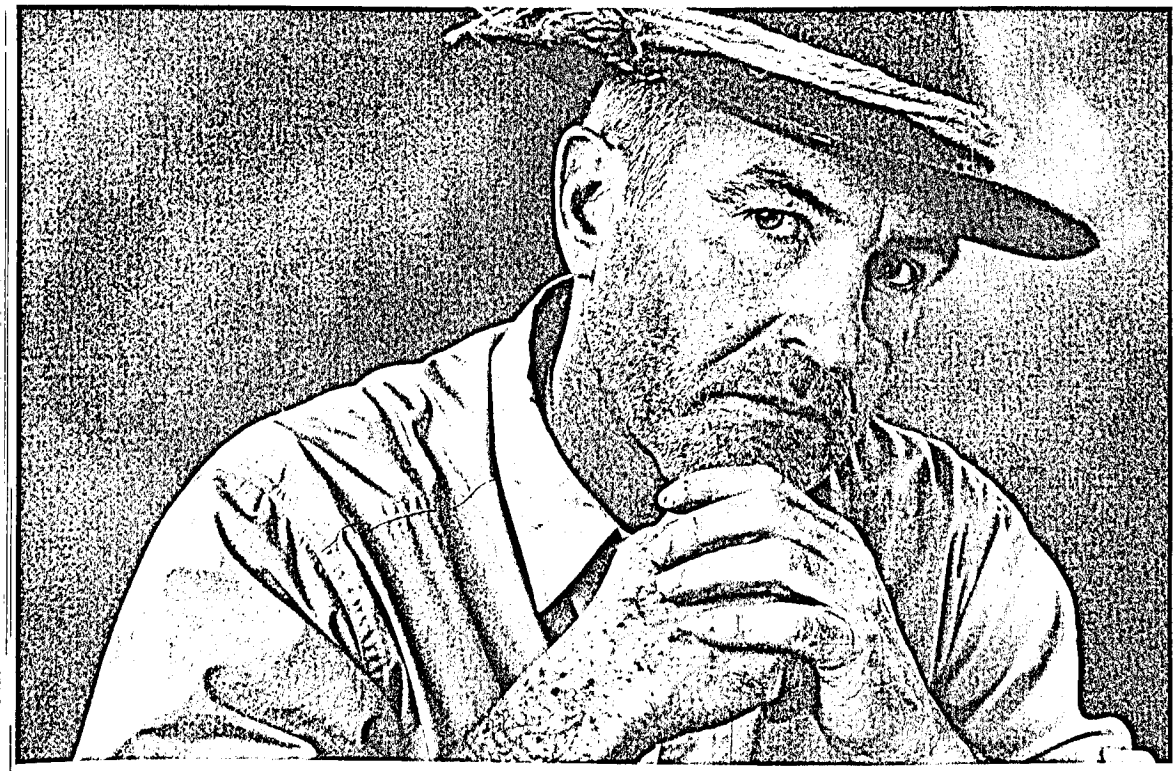
John Cooley, took the time to listen extremely carefully to what the cicadas were doing. They discovered that the females also make a sound, a tiny wing flick, and that the males have to make three precise sounds in succession before mating actually happens. With three species in play, this means you can hear up to nine separate sounds at any one time during a cicada "invasion." It's like a whole musical composition, determined by evolution. At first it's all white noise, a kind of menacing surround-sound, but with careful listening you can make out all these distinct parts. Here is an example where only careful listening in a musical way led to the advancement of science.

And think of the grand song of the humpback whale, a carefully structured aria up to thirty minutes long, repeated over and over again up to twenty-three hours at a time. Each male whale sings pretty much the same song over and over again only during mating season, winter in the tropics, and not in the summer when they are either in the North or the South traveling and feeding. The whales all sing individually, not really interacting with each other, but they change their song in tandem all at once, so that the song evolves from week to week, month to month, year to year. Why do they all want to change together to a new tune even though they all want to sound the same? We really don't know. Some experts say it's just like the human pop charts. We always want a new song that sounds enough like the old songs so everyone will like it. But then we get bored.

Once again, only the males are singing so it is assumed that the songs are to attract the attention of females. But after forty years of studying this behavior, scientists have *never* seen a female whale show any visible reaction to a singing male whale. Other males seem interested though, and sometimes two nearby singers will stop singing, swim close to one another and then continue next to each other in parallel, only starting to sing when they separate far enough form each other for their songs to be distinct. Is this the moment when a new song is telepathically transmitted from one whale to another? Who knows? We don't even know convincingly how these whales *make* their songs! No air leaves the whale as the sound reverberates across the oceans.

These are just three examples of how a musical approach to learning the sounds of nature can expand our conception of what such sounds might mean. As a musician who believes in the power of improvisation in unfamiliar situations, I continue to believe that interesting music can result from playing live with other species. You can hear and read about this work in my books and recordings *Why Birds Sing*, *Thousand Mile Song* and *Whale Music*, and *Bug Music*.

Over time my work gets increasingly identified with these interspecies musical interactions. I want it to be more than a gimmick or a shtick and hopefully it actually results in interesting music. But only time and the public can determine that. At least if you want to know what it is supposed to mean, I have written more than enough words about it. But still, the musical encounter is the best part. Listen beyond the limits of your species, and you will expand the boundaries of your world.



Gordon Hempton is an acoustic ecologist who has traveled the globe engaged in capturing the rarest sounds of nature as they occur in the absence of man-made noise. He is interested in what the Earth is telling us and challenges the evolutionary notion that the ear evolved in order to hear speech. On the contrary, the ear is expert at detecting nature sounds and has the ability to do so over long distances and with great accuracy. Due to the global environmental crises, Hempton believes we must once again turn our listening to the Earth and strive to preserve the steadily vanishing natural soundscapes. With this in mind, Hempton encourages us to act with some urgency, for he reports that the average daytime noise-free interval in our wilderness areas and national parks has shrunk to less than five minutes.

Hempton has received recognition from the Charles A. Lindbergh Fund, the National Endowment for the Arts, and the Rolex Awards for Enterprise. His sound portraits of endangered natural soundscapes have been featured in *Smithsonian, Time*, and *Nature* magazines. The national PBS television documentary *Vanishing Dawn Chorus* earned him an Emmy for Outstanding Individual Achievement in Sound.

18

The Dawn Chorus

I seek out places in nature much like a landscape photographer, but instead of recording light, I capture sound. My pursuit of soundscape portraiture has taken me to the Kalahari Desert of South Africa and many other of the world's most remote places to escape noise pollution and capture nature at its most natural. My preferred microphone system is Fritz, a human-head shaped binaural "dummy" that replicates our hearing. I travel with Fritz because I want to stay within human possibility and champion the often overlooked and undervalued role of hearing for falling back in love with Earth. In the end, we simply save what we love. Listening to beautiful natural places makes preserving them not so much an obligatory chore as an awakening joy.

I might be called a soundscape artist, but I think of myself more like a messenger, delivering something that we all understand once we hear it—Earth's music. When my work on location is over, there is nothing more for me to do than choose start time, end time, fade-in, fade-out. I don't filter out noise pollution or cut out a jet overflight or sweeten birdsong. What I hear through my headphones in the field is what listeners get on the MP3 files they download or the CDs they purchase.

My life's work is really educational preservation: spreading the word that spectacular natural places are worth preserving not just for their scenic beauty, but also for their sonic wonders. And with man-made noise now girding the planet, Earth's most pristine soundscapes are seriously endangered. Noise pollution knows no bounds.

Unlike classic landscape photography, my work does not have a frame that can exclude unpleasant reminders of the modern world. A photographer can opportunistically shoot an elk from the window of his car and no one would be the wiser. That is not possible with binaural recording—there is no out of frame and no blind side. Similarly, a photographer can move slightly in one direction to use a tree to block a view of a garbage can. Sounds, however, penetrate objects, go around walls, and travel great distances. Man-made noises can travel as far as 20 miles, barging into a tranquil soundscape like a toxic urban smog.

My art, by necessity, can occur only at the world's most remote places, far away from modern fossil fuel-driven, noise-polluted areas. Accordingly, my style of nature sound recording is expensive and time consuming. It has taken me decades to produce a body

of work that others, using less faithful methods of sound recording might accomplish in a few years using digital processes to scrub out noise. Such fast track methods, however, will never capture the full sonic beauty of true wilderness places, because noise pollution disrupts the normal bio-communication processes of the native animals. The result is akin to a photograph of clearcut forest decades after replanting versus a photograph of an ancient old growth forest. In both cases, the difference is obvious to the ears and eyes of the audience when side-by-side comparisons are possible.

When I began my recording career I worked a day job as a bike messenger in hilly downtown Seattle, an occupation that afforded me the freedom to take time off from work on short notice—sometimes weeks at a time—to pursue my true calling as the Sound Tracker®. I met and married a fellow bike messenger in 1984; soon followed our son in 1985. Julie and I were nearly always broke, but confident that someday my nature sound portraiture would pay off. Year by year, I realized, many of my cherished recording spots were "vanishing," unnoticed by anyone but me. Surely, my recordings would only appreciate in value as they became more difficult to record. We worked together as a team, both riding for Bucky's Messenger Service, both parenting, and as often as possible, I'd head off alone into the wilderness to record vanishing natural soundscapes.

The winter of '89 was particularly hard. I developed pneumonia and couldn't work. With no savings, we were quickly destitute. Our water pipes froze and burst. We burned some of our furniture in the fireplace one particularly cold night. The next morning, wondering if my Sound Tracker® dream had come to an end, I imagined the suffering my ancestors—German, French, Basque, Dutch, English, Irish, Welch and more—must have endured in centuries past. Outside my window, a Pacific wren sang its twittering, Northwest classic tune from the seclusion of a frosty hemlock bough. Slowly, instinctively, no doubt, my mind latched onto the morning light that was advancing outside my home. Imagining that primordial, essential passage moving ever westward, I thought of sunlight lifting birdsong off the surface of the earth—a continuous wave, a planetary tune. I spent all day in bed, ill, but filled with joy. I reached for paper and a pencil, thinking: This global tune has evolved in composition with the evolution of life itself! My heart swelling, my spirits lifting, I wrote at the top of the page: "The Dawn Chorus." And continued to draft a project that would take me to seven countries on six continents.

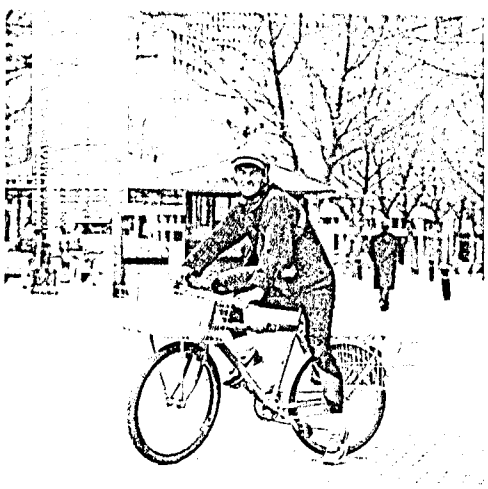


FIGURE 18.1 Gordon Hempton at his day job as Bucky Messenger in Seattle, Washington, in 1988. (Photo by Wally Hampton Photography)

The Dawn Chorus 1989

Gordon Walker Hempton

This project plans to record the dawn chorus of birds at different locations throughout the world. These recordings will then be combined sequentially into a program in audio-cassette form that will continuously offer the musical sounds of dawn - a never-ending wave of bird song that follows the rhythm of the earth's rotation as if the sun never stopped rising and the birds never stopped singing.

A combination of beauty and precision since time immemorial

Each day when the sun reaches six degrees below the eastern horizon, enough ambient light is created to distinguish objects and the avifauna begins to vocalize. This event is so well regimented that some bird species have served as early morning alarm clocks. Birds evolved to vocalize at dawn, presumably to take advantage of the transmissive, non-turbulent atmospheric conditions which are frequently present at this time of day. Vocalizations may range from simple calls to elaborate songs and serve a variety of functions (e.g., territory identification, mate advertising, family bonding, etc.), depending on the species involved and the season.

Dialects distinguish one dawn chorus from another, and the order of species vocalization further characterizes each locality. Insect-feeding birds are the first to sing; grain-feeding birds are the last to sing. The composition of the dawn chorus is so expressive that it is possible to correctly identify a place, the season and time of day on the basis of the recorded chorus alone. The dawn chorus, like dawn itself, has circled the planet as an endless wave for millions of years. In this respect, the global dawn chorus is one long song with a composition that has paralleled the evolution and population dynamics of birds. It is precisely this perspective, "Planet Earth as a musical instrument," that this project will explore.

The global dawn chorus circles the globe at approximately six degrees in advance of sunrise. Time of year, latitude, temperature, wind and cloud cover all affect the onset of singing, chorus complexity and duration. Generally, the dawn chorus is best developed during spring in temperate latitudes, and may last for hours. Summer chorus is less pronounced while fall often has a peak chorus similar (but weaker) than spring, caused by photo-periodic hormone production; winter chorus may be much reduced or even appear absent on unfavorable days. However, while the dawn chorus in one hemisphere is seasonally waning, the dawn chorus in the opposite hemisphere will be gaining; thus, the global dawn chorus transcends local conditions. At any given time a wide spectrum of chorus development is present across the face of the earth. In this respect, the surface of the earth, or more specifically, the vegetation

(which ultimately supports avian populations) may be viewed as a living and dynamic musical score. As the earth turns, this musical score is released by the sun's rays toward silent space as if by one, colossal piano.

Site selection and recording procedure

I propose to survey the global vegetation and develop an itinerary that will allow me to follow the dawn chorus of songbirds as it circles the globe and that will establish a connection between songbirds and man or, more specifically, the dawn chorus and civilization. If we examine the different vegetation types, we can see that grasslands and the cereals they produce have had an important role in the development of the dawn chorus and the dawn of civilization. It was here also, particularly when diversified by shrubs, trees and surface water, that the oscines or songbirds have sung the long history of vocal evolution. So it will be across the grasslands of the globe that the Dawn Chorus Project will be executed to link bird and man, time and harmony. It is not the earth, after all, that will be played as a musical instrument, but instead it will be the imagination and attention of the listener across a field of many possibilities.

Six representative grasslands will be selected from the different continents around the world on the basis of similarities in climate and seasons, vegetation structure and associated topography. Avifauna differences will not be controlled, but rather, because different social environments will exist in the separate avian communities, similarities in the basic sound qualities will be distinguished by an expressive vocal heritage. Site visitation will be planned to coincide with either the spring or fall peak chorus activity and to emphasize nuptial rather than territorial songs. Special consideration will be given to the Egyptian site of Amenhotep in the ancient city of Thebes. It is here, over 5,000 years ago, that two colossal statues were constructed in such a way that the first breeze (generated by the influence of solar radiation on a non-turbulent air layer) would cause the stone cavities to resonate and, thus, "speak" at the gate represented by dawn.

The dawn chorus for everybody

The field recordings will be deposited at Cornell University's Library of Natural Sounds, the world's largest facility of its kind. The Library's studio facilities will be used to assemble the global dawn chorus audio program. The final program will be produced and distributed on audio-cassette under the title, "The dawn chorus: A special time to listen." Descriptive literature will also be distributed to stimulate radio broadcast network interest, both public and private, for interviews and broadcasts. It is my hope that the binaural recording aspects (which will allow audiences to experience a three-dimensional sound sensation) will attract considerable attention to the project's concept and create a very intimate feeling on the part of the listener for the global environment as a whole.

The Dawn Chorus project was ambitious, to say the least, and I had absolutely no experience at raising money. But from that morning in bed sick with pneumonia—I simply knew it would happen. Others would point out that I had no assets, no collateral—not even a passport. Henry Ford once said, "Obstacles are what you see when you take your eyes off the goal." I could hear my dawn chorus—all I had to do was fill-in the gaps.

That started to happen when PBS became interested in producing a 60-minute television documentary... should I secure my funding from other sources. I knocked on plenty of doors including neighbors, business investors, and relatives. Eventually I sold enough investment shares to raise *almost* the full amount. Julie and I would have to scrape by on almost nothing.

Then, at the 11th hour, PBS expressed concerns that my plan to visit only grasslands on six continents was not varied enough to hold the audience's attention for a full hour. They suggested I also record in more exciting places like jungles and deserts. I complied. I changed the itinerary to this: start with the rugged coastline of Washington State; then move onto the rain drenched slopes of Hawaii's Haleakala volcano; then the fire-swept Outback of Australia; the enchanting Sinharaja Forest Reserve of Sri Lanka, the draught-worn Kalahari Desert of South Africa, the pine covered interior mountains of Spain; and finally, the wildest of all—the vast Amazon rain forest for the grand finale. They agreed. The project was finally a go. With tickets in hand, PBS producer Rob Reed and I set off on 9/9/90. A two-person production team on a sunrise chase around the world.

Quickly I discovered that new places present new dangers. I would encounter crocodiles, viperous snakes, leopards, lions, and disease. My instincts proved not only to be my best listening skill, but a survival skill as well. One morning I walked alone into the Sinharaja forest as quietly as I could. Above me through the branches I could still see the cloudless starry night. The forest dripped heavily... rain drops stored on leaves, many of which seemed to be jungle stages for frog *beeps* and *peeps* and insect *clicks* and *snaps*. The music was mesmerizing, and I was filled with expectation about what this dawn chorus would bring. But more than a mile from camp I was hit by an unanchored jolt of panic. I tried to shake it, "Look you fool, you have come halfway around the planet to get this recording. Just push record and sit still." I did so, but remained fearful until I realized: I don't need to be here. I'll just leave my equipment running and retrieve it later.

FIGURE 18.2 Gordon Hempton, The Sound Tracker®, uses his binaural microphone, Fritz, on the Kalahari Desert of South Africa to record a sound portrait. (Photo by Rob Reed)

Months would pass before I would learn the wisdom of my decision. Back

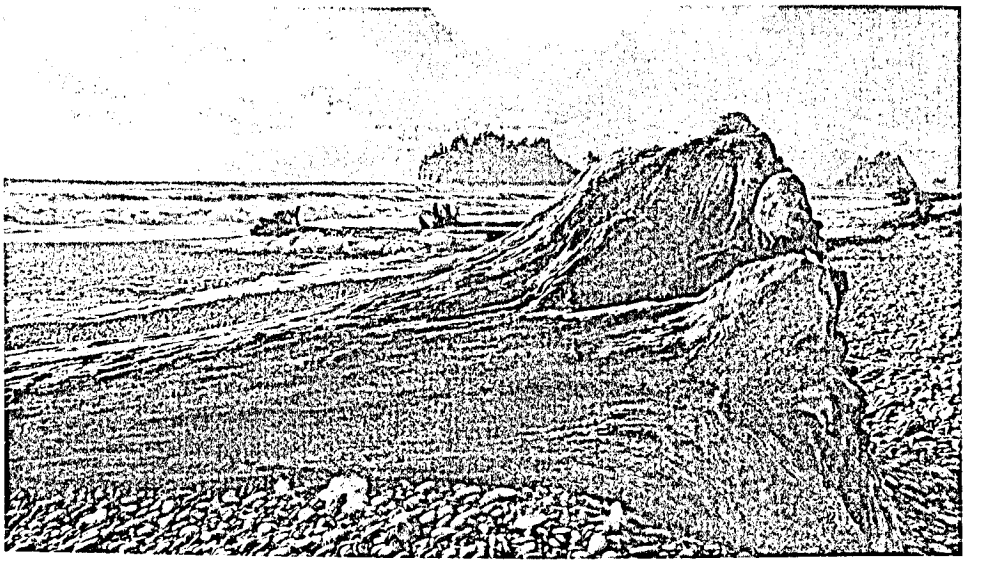


FIGURE 18.3 Near Rialto Beach, Olympic National Park, Washington. (Photo by Gordon Hempton)

home in my Seattle studio, listening once again to that jungle soundscape, I heard first my retreating footsteps... and then the guttural growl of a nearby leopard.

Eventually, the westward-only *Dawn Chorus* trek returned me to where we had started on Rialto Beach at Olympic National Park. It was at that moment and that moment only that my knowledge that the earth was round became *spiritually* true—I was forever changed.

I went into the studio as rapidly as I could before the afterglow could disappear under the burden of other accumulating work and unpaid bills. All the audio had to be listened to in real time, selections made, notes taken, and then the chosen works taken to a professional studio for assembly, as digital audio workstation (DAW) technology was then still in its infancy.

At this stage in the production process a second artistic process needed to occur. My art until then had been defined by only the location, time, and placement of the human "dummy head" microphone. Now, even knowing the sequence of locations, I had to arrange the sound files into a meaningful work, one sound file gradually emerging out of the previous one, all the way around the globe. I soon discovered that here, too, the intuitive ear must rule. I let my instincts guide me. I placed and pulled files numerous times as if assembling a puzzle. The only rule I enforced was each sunrise chorus had to remain in the correct sequence of dawn's advancing light. In the end, I began the continuous wave of birdsong not in Washington State, where I'd first pressed the record button, but rather in Australia. Why? Because of a particularly rapid and repetitious owl hoot that reminded me of a ticking stopwatch—the sun had just reached six degrees below the eastern horizon.

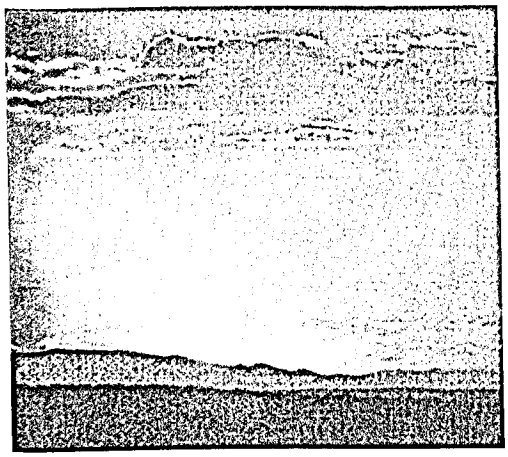
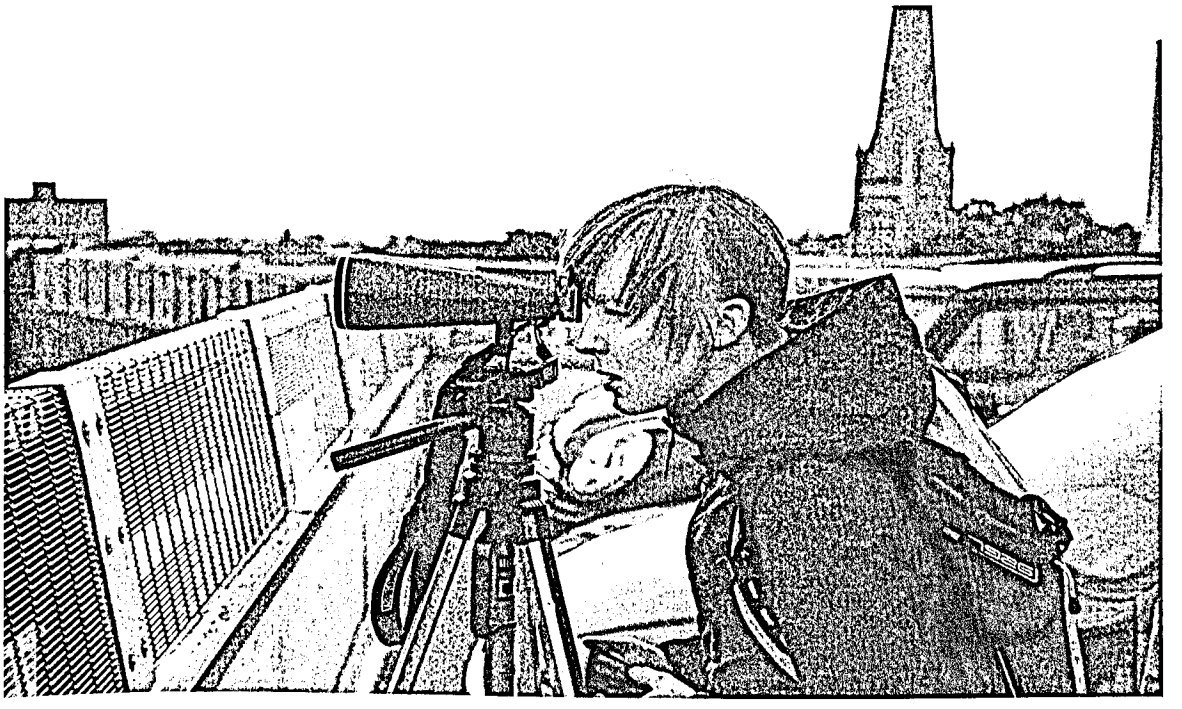


FIGURE 18.4 Global sunrise. (Photo by Gordon Hempton)

Finally, I sent a promotional recording to a small circle of friends. I made revisions based on their feedback and shrunk one 24-hour cycle to a little over a minute—the length of my audience's attention span. I sent *Global Sunrise* out to various media outlets, including NPR and National Endowment for the Arts. "It is the sound of the awakening... a hallelujah chorus... His recordings will immortalize the few remaining quiet corners of the Earth," wrote Lisa Krieger in *The San Francisco Examiner.*

Meanwhile, Rob Reed completed *Vanishing Dawn Chorus,* which aired on KCTS, Seattle, and then aired nationally on PBS in 1992. PBS audio engineer Bill Fast, who synchronized my sounds to Rob Reed's images, and I both received Emmys for *individual achievement* in sound. Those who backed me financially were all repaid, I'm happy to say with 20 percent interest on their faith in me.

It was Walt Disney who said, "If you can dream it, you can do it." With a confidence boost from *The Dawn Chorus,* I have not stopped dreaming. Preserving recordings of pristine natural places is not enough. Should unbridled noise pollution continue to claim every last corner of the world, my recordings will only serve to remind us of the tragic loss of Earth's daily, live natural concert. It is our birthright to listen to nature undisturbed and reclaim our spiritual connection to our ailing planet. I urge you each morning to listen to the world around you—all of it: nature's music and our noise pollution. Then simply move forward in your day, save what you love, limit what you don't.



Dawn Scarfe is an artist whose work investigates resonance, perception, and environmental atmospheres. She is interested in how the sound of particular atmospheres can seem to convey an emotional charge and how people respond to changes in their surroundings. Scarfe works across a variety of media and contexts including site-specific installation, performance, and field recording. Her works are explorations, experiments, and investigations that integrate elements of process, improvisation, and uncertainty. She is an artist of deep conviction, driven by curiosity.

Scarfe is based in London and has exhibited and performed in forests, parks, botanical gardens, city centers, galleries, and concert halls across the United Kingdom and internationally.

19

Bivvy Broadcasts

My work includes site specific installation and performance. It uses fragile and fluid materials such as glass and sound to re-focus or tune into aspects of an environment. Recurring themes are sympathy and sensitivity, or how things respond to their surroundings of their own accord.

Listening Glasses invites people to discover musical tones in the sound of city parks and streets by listening through tuned spherical sculptures that resonate and amplify specific frequencies of sound. *Bee Strings* uses violin strings to render the wingbeats of bees more tangible, following a conjecture from natural philosopher Robert Hooke: if we know the rate at which musical strings vibrate, we can infer that a bee sounding a G# beats its wings over 200 times per second.

My installations have a light footprint and aim to merge and mingle with, rather than stand apart form their context. *Canopy* uses white noise to alternately mask and reveal the ambient sound of Meeting House Square, Dublin. *Tree Music* is a composition tuned to the sound of its environment, played through a network of small speakers light enough to move with tree branches in the wind. As the speakers swing back and forth, the Doppler effect gently modulates their sound.

A *Bivvy Broadcast* is a guerilla-style exercise to stream live sound through the night while sleeping in a bivvy on a forest floor. It is set up after dark in unfamiliar surroundings using a small microphone, a Raspberry Pi computer, batteries and a 3G connection from a mobile phone. Listeners are asked to keep vigil between 11 p.m.-7 a.m. (UK time) over the audio stream, ideally playing it quietly into the room they are sleeping in. Emails and texts between streamers and listeners are logged and later published, exploring how sounds are interpreted in and out of situ.

Starting points for the project included the question of whether we can listen while sleeping and a desire to connect with diurnal, nocturnal and seasonal rhythms of light and sound that shape our sense of time and duration. Added to this was the nagging concern that while the Internet allowed me to live a more nomadic lifestyle, I spent too much of my time indoors staring at screens rather than being directly engaged with the outside world.

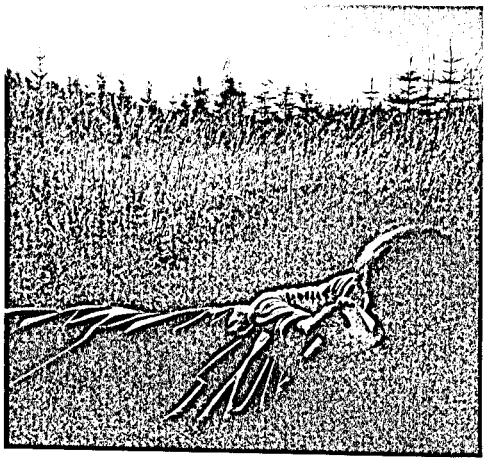


FIGURE 19.1 Dawn Scarfe, *Bivvy Broadcasts.*

The project evolved through an unusual roaming residency with Forestry Commission England and Sound and Music in 2012. Intrigued by the idea of a residency across multiple sites, I set out to explore forests I hadn't visited before. I became interested in how the onset of nightfall transformed my sense of space and how I used my senses. As my vision faded with the light I relied more on the sound and feel of the ground underneath my boots to know what kind of path I was on. When the night set in the darkness became intense, almost claustrophobic in the way that it enveloped me and everything else around, apart from odd glimpses of the night sky through the trees.

I remember feeling disturbed that there was nothing in between me and the sounds of the dark, and resolved to immerse myself in this precarious condition by sleeping out in a bivvy bag on the forest floor. This magnified the sense of exposure, as bivvy bags take time to wriggle in and out of, movement is restricted, and the face remains open to the elements at all times.

This prone situation led me into an anxious state of listening, the result of not knowing what I might encounter in a forest environment and being very sensitive to the absence of boundary or space between myself and the amorphous blackness of the outside. Every tiny ambiguous scratching, snapping or rustling sound seemed amplified to unnatural proportions. I imagined all sorts of traumatic scenarios resulting from these slight sounds in the foliage: angry badgers pouncing and scratching at me, slugs sliding into my bivvy or poachers stumbling across me in the middle of the night. These paranoid thoughts became less disturbing the more I bivvied, but still there was a gulf between the nature of the sound and the predicted consequence, coupled with a sense of urgency in listening. I rarely fell into a deep sleep. Instead, through a series of semi-conscious states I remained compulsively engaged with what I could hear.

There was something very compelling about the intensity of this kind of listening. Alvin Lucier expressed a similar fascination:

> One of my fantasies is having been a French Canadian fur trapper in the 19th century in the American West. Those men often traveled alone and lived under very difficult survival circumstances. Before they fell asleep at night they made a mental catalogue of all the sounds that were around, so that if—while asleep—they "heard" a sound that wasn't in the catalogue they had to watch for it: it could be an enemy or an animal. That way of life, that high degree of attentiveness, appeals to me very much.

After a few forest bivvys I began to recognise patterns in the ambient sound. These included the dusk chorus, and how roads became more prominent after sunset, not through an increase in traffic, but because sound seemed to carry further. Subsequent Googling suggested this was an effect of temperature inversion. I listened with interest to how the barks of muntjac deer changed character as they moved to different areas of the forest through the night, mellowing with distance. Around 3-4am there was often a lull in activity, a real deadness in the night and a new level of quiet, before the onset of the dawn chorus, usually a striking eruption of a multitude of bird calls signalling the welcome return of the light.

The rhythms and preoccupations of my bivvy routine were very different from those of my usual urban life. In London, plugged into the grid inside, or outside under a blanket of orange light pollution, it never gets truly dark. Birds sing at odd times of the night. More traffic and general activity makes it harder to hear quiet sounds at a distance. I tune in and out of sounds rather than being in their thrall, as I am out in the dark woods.

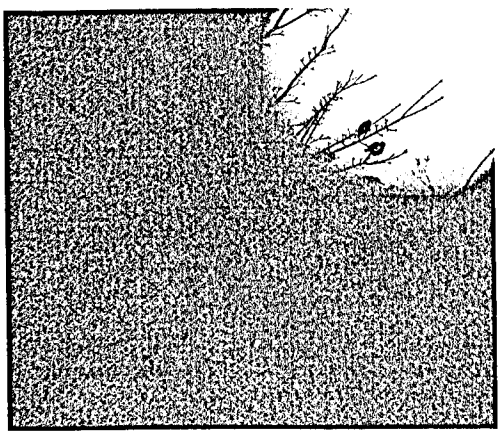


FIGURE 19.2 Dawn Scarfe, *Bivvy Broadcasts.*

The idea to open up an audio channel between my forest bivvys and people in domestic environments was partly to find out whether any of the suspense of that unique listening situation could be conveyed over a live stream. On a more instinctive level, it reflected the impulse I had to send out some kind of signal from remote places. I began to think of broadcasting ambient sound as a one way line of communication. Admittedly, I thought it reassuring that people might be listening in should anything terrible happen to me.

In *Reverie and Radio*, Gaston Bachelard proposes the creation of a psychic radio through which people could enter the nocturnal world of their own choice. He suggests the invisibility of the radio—its *lack of face*—opens up an *axis of intimacy* or *inward perspective* in the listener. In *The Anxiety of the Lonely Listener,* Salome Voegelin suggests that the motivation for radio reflects the fragility of communication and *an awareness of the solitude of one's position.* With the bivvy project, I wanted to explore the connections between broadcaster and remote listener: both lost in the dark, exposed to environmental sounds from an unknowable place. I hoped they might be in a similar restful position, listening together through the night, with varying degrees of awareness of the world around them.

It was an option to install the streaming technology in a forest and leave it running unattended, reminiscent of the *Wilderness Radio* described by R. Murray Schafer and Bruce Davis in the '80s. However, I considered the act of being there important, for me and for potential listeners. Each bivvy was a chance for me to be in a prolonged, captivating listening situation: to listen as if my life depended on it, with the same *high degree of attentiveness* as Lucier describes above. Added to this, I felt that it would be more compelling to tune in to a person quietly sleeping in the woods, than a lone microphone in the woods.

Initially I wasn't comfortable with the idea of taking a lot of technology into the forest. Part of the attraction of being there was the opportunity to be off grid and off line. However, I downsized from a laptop to a compact Raspberry Pi computer and once programmed, the Pi could be powered up and left to do its streaming without any further tinkering. In the end, the broadcast set up was compact, portable, and not much of a distraction. I didn't address listeners directly or perform in any way for the stream. The microphone was placed around 10 metres away from my bivvy, far enough that I didn't dominate the sounds of the broadcast, but close enough that I was still part of it through whatever movements and murmurs I made through the night.

Listeners accessed the stream through my website as well as through broadcast partners including Soundart Radio, soundCamp and Resonance FM. Bivvys were scheduled weeks in advance, but exact locations were kept secret until after the event. This was partly due to me not wanting to be discovered in the act, and to keep information to a minimum so that, like me, listeners were in the dark about what they might hear.

Exactly where I slept depended on where I could get 3G signal, and be far enough away from roads that they didn't overwhelm the broadcast. I realised that even in Kielder,

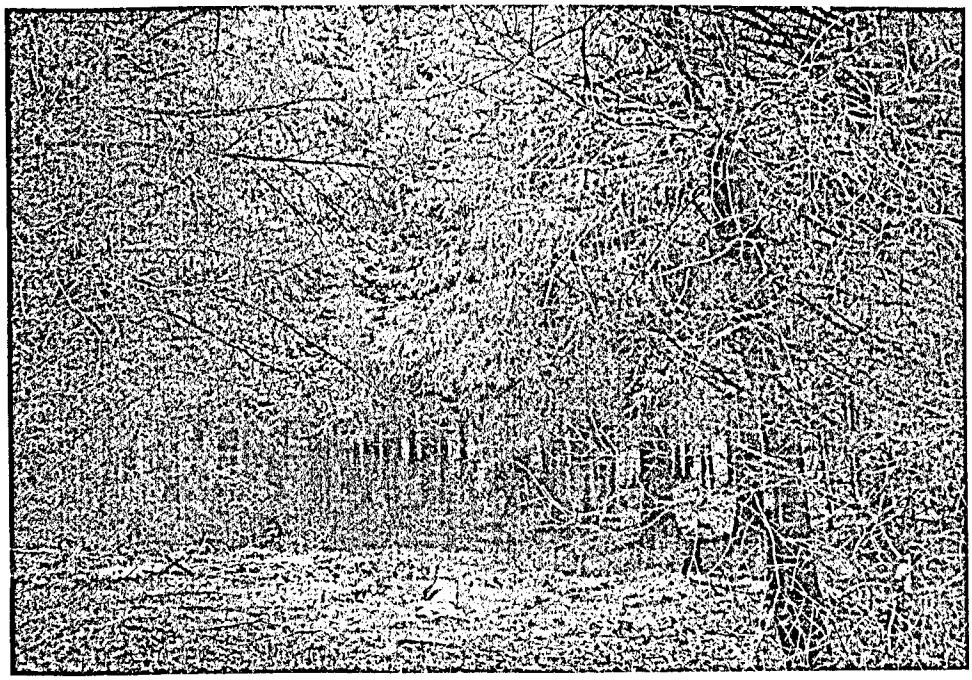


FIGURE 19.3 Dawn Scarfe, *Bivvy Broadcasts.*

England's largest forest, there were regular sounds of human activity; mainly from farming, road and air transport. The bivvys didn't attempt to escape sounds of civilisation, as this isn't really possible in England and especially not in its forests which are all cultivated to some extent, and often bisected by motorways and flight paths. The aim was to get enough distance from urban centres to reflect on the differences between urban and rural ambience, and to explore the imagined space of the forest as much as the physical reality.

From listeners' communications, I noticed a tendency to confuse sounds of roads with those of wind or streams, microphone noise with rain, and chainsaws with animal calls. For me in the forest, every sound was potentially threatening and kept me on high alert. In contrast, most listeners found the sounds relaxing. Of the people that tuned in for extended periods, some suggested that the sounds had influenced their dreams, others reported that they slept throughout, largely oblivious. The process of bivvying and comparing my experience with that of others has helped me to appreciate how much of ourselves, and of our unique circumstances we hear in sounds.

The project has led to collaborations with South London Gallery's youth arts forum the Art Assassins, and soundCamp, an artist collective based in London producing outdoor listening events on International Dawn Chorus Day in May each year, linked by Reveil: a 24 hour radio broadcast of the sounds of daybreak, relayed live by audio streamers around the globe.

Photo by Alex d'Emilia

David Monacchi is a sound artist, researcher, and eco-acoustic composer. He is principled, persuasive, and driven by a passion that inspires his work and infuses his philosophy. Monacchi has been developing his cross-disciplinary project *Fragments of Extinction* for nearly 15 years, conducting field research in the world's remaining areas of undisturbed primary equatorial rainforests. Monacchi is pioneering a new compositional approach based on 3D soundscape recordings of ecosystems to foster discourse on the biodiversity crisis through music and environmental sound-art installations.

Monacchi is the recipient of multiple awards throughout Europe and North America, including a Fulbright fellowship at University of California, Berkeley, in 2007. He has taught at the University of Macerata (Italy) since 2000 and is currently Professor of Electroacoustic Music Composition and Eco-acoustics at the Conservatorio "G. Rossini" of Pesaro (Italy).

20

A Philosophy of Eco-acoustics in the Interdisciplinary Project "Fragments of Extinction"

Statement and Project Background

I am a human being. I am also an artist, and as such, my work entails an understanding of how to feel and interpret things. The planet on which I was born will radically change within my lifetime, and the decline of the entire biosphere is now unavoidable. Mankind is responsible for the massive changes that are happening, which will affect the survival of the majority of creatures in all of Earth's biomes. This ecocide is progressively damaging the magnificent choirs of natural sound, *eco-symphonies* we have not even heard, much less recorded. About 15 years ago, I felt compelled to invest my life in a sound-art project, which would promote public awareness on the most silent catastrophe of our times: the *Sixth Mass Extinction.*

According to the Millennium Ecosystem Assessment (signed by some 1360 world scientists and released by the United Nations in 2005), the current global extinction rate is between 100 and 1,000 times higher than it would naturally be. Immediate projections for the future indicated that this rate may reach 12,000 within our lifetime. As a result of the direct human pressure on ecosystems (mostly deforestation and overexploitation) and the effects of human impact on the biosphere (as invasive species-triggering and pollution) an exponentially growing number of the planet's recently estimated 8.7 million living species are going extinct. The rate of 30,000 species per year was already predicted in 1993 by Harvard biologist E.O. Wilson (estimates which order of magnitude has since been revealed correct by most current studies), which equals to some 3 species going extinct every hour. Current estimates do not even include climate change. This is all the more shocking if we consider that, at present, only 1.9 million species have been described, most of which have barely been studied, if at all. Of all known species, one in four mammals, one in eight birds, and 41 percent of amphibians now appear on the IUCN Red List of threatened species. We are facing the collapse of life itself.

From an ontological point of view, our species is only one among others on Earth's network of interconnected ecosystems. Every single species, the smallest micro-organism and the largest mammals, all thrive and conduct their lives without any external support device to survive and propagate their own genetic heritage. Rare individuals of the same species meet in vast spaces and mate through no force but their own natural communications. I am speechless as to how these coordinated and interdependent mechanisms can happen at every scale of life, within extremely complex processes of natural selection and co-evolution, and how these cycles have slowly refined themselves over the last 65 millions of years.

FIGURE 20.1 Borneo, Brunei, Kuala Belalong, September 2012. The author recording in remote dipterocarp forest.

I wish I could regain the perspective of a guest and in-depth observer of this highly evolved web of life. The time has come to reverse the anthropocentric view of evolution and to envision a new inner space for a deeper understanding of the complex, now vanishing equilibrium of the natural world. To achieve these aims, I have used environmental sound of ecosystems as the object of investigation and conservation, as the model for compositional creation, and as the entity for designing worlds of perception for diverse audiences (Fig. 20.1).

It was in the quiet of a December evening in 1999 when I posed myself the question of how could my work as a musician communicate and effectively encourage concern for the ongoing environmental disaster of deforestation and species extinction.

I had to determine how my art could be a platform and forum for environmental awareness, while maintaining a scientific and ecological methodology. I considered the tropics to be the ideal setting in which to record and collect representative data of the oldest and most diverse sonic ecosystems on Earth. It very soon became clear that this was a life's work, which I named *Fragments of Extinction. Fragments*, because all the traces we will be able to collect out of the endless and unknown sonic heritage of primary habitats are inevitably small pieces of an entire world, of a now broken organism; *Extinction*, because along with its biodiversity, we are losing the intelligent sound of the natural world.

At that time, I was still working as an electroacoustic composer in a broad range of music, performative arts, cinema, video, installation art, sound design, and sound engineering contexts. All my compositional work was based on personally collected

soundscape recordings, which I used to study, process and recompose within narrative or purely documentary perspectives and approaches. A frame of reference was attained at the World Soundscape project in Vancouver in 1998 and nurtured under the direct influence of composers and scholars, such as H. Westerkamp, B. Truax, R. M. Shafer, S. Sciarrino and W. Branchi. The work that I now consider most important was done in the field: thousands of hours of listening activity and observational speculations conducted during the 1990s in the natural habitats of the central Apennines in Italy and in several trips to natural parks in Africa, South America, Canada, and the United States.

When I first decided to go work in an equatorial area (Amazon—February 2002), the hypothesis I cultivated during those listening fieldworks, that I would find systems of acoustic order in the soundscape of a primary forest, was strongly confirmed. I was witnessing an entire biological community displaying a coordinated behavior, in which every segment emitted sound with several, distinctive levels of pattern arrangement, periodicity, regularity, grouping, and overall interdependence. My first nights recording in the Amazon's flooded forests were actually some of the most powerful aesthetic experiences I have ever had; I was there with my entire body, sensing all the subtle environmental changes (temperature, humidity, wind, light quantity, etc.), realizing they were the exact cues activating all the sounds in the habitat, which my microphones and my ears were experiencing. Similar to an electroacoustic music composition, I was in front of a complex spectrum of sound entities with clear individual identity, sometimes aggregating in masses and often times maintaining separation in an extremely efficient tissue of narrow bandwidths. Moreover, this perceived whole system was dynamically changing and balancing over time in an organic sequence of states—exactly what one finds in a good electroacoustic music piece. But all the sounds of this habitat were from living individuals, most of which were tiny insects or amphibians (when not birds and mammals), which were simply unfolding their life and communication functions. Their species *Umwelt* was furthermore dependent on the complex soundscape behavior, forming what I was experiencing as an intelligent sonic ecosystem.

Over time, it has been quite difficult to accept that I was progressively losing my interest in creating traditional musical compositions to instead make space for a new form of personal consciousness of what I then referred to as *organized soundscape*. This was directly related to my original assumption that the more intact a soundscape is, the more structured and balanced systemic behavior it would display. The reading of Bernie Krause's work about the "niche hypothesis" in 2004 gave me the definitive signal that I was going in the right direction and that an entirely new field of ecological study and aesthetic thinking had started its course.

The intrinsic question of how a composer can work within such a perfect set of data was a major concern for years and resulted in an entire palette of expressive means and technical devices developed within the long-term project, *Fragments of Extinction*.

Fragments specifically investigates the acoustic biodiversity of untouched tropical forests, communicating to the large public of museums and theatres, how undisturbed

nature has shaped its sonic habitats in order to maximize functionality and efficiency within diversity, and how these concepts can be understood through ecological science and experienced through sound-art.

The project, in its final form, concentrates on the three major areas of intact equatorial rainforest that remain: in the Amazon, Africa and Borneo. At least three reasons motivated the selection of the equator (5° North and South, as area of pertinence) as relevant for the project: 1) circadian cycles are regular throughout the year and seasons are minimal, thus time-dependent sonic phenomena can be studied more easily; 2) equatorial forests contain the planet's greatest biodiversity and thus the most complex soundscapes; 3) many of the oldest ecosystems on Earth are found in equatorial forests.

Through extensive fieldwork conducted in these remote areas since 2002, I have collected unique 24-hour sound portraits of rare intact species ensembles recorded for the first time with high-definition space-preservative 3D technologies. These research technologies allowed me to gather data not only in the time-frequency domain, but also to store the entire spherical spatial information of soundscapes.

The recordings collected are important data for scientific investigation. The newly established field of Eco-acoustics now provides the necessary conceptual framework and analytic tools to investigate the relationship of natural and anthropogenic sounds with the environment, on population and community levels. The evaluation of diversity and complexity of acoustic habitats constitutes a radically different approach from traditional bioacoustics.

The analytical outcomes of soundscape exploration, revealing the intricate co-evolved sonic behaviours of species in primary ecosystems, are also aesthetically relevant. *Fragments of Extinction* aims to present a new paradigm of artistic exploration and integration—a bridge for making these soundscapes accessible to audiences, to ultimately foster concern of the current biodiversity crisis.

Over the last 15 years, *Fragments* has developed in several directions, scientific (conservation biology and intangible heritage preservation, eco-acoustics analytic studies, innovation in space-preservative field recording technologies) and artistic (soundscape composition and acoustic ecology studies, 3D-sound production and post-production methodologies, multichannel and full-periphonic installation practices), maintaining a strong interdisciplinary mission and spirit, while proposing a new way to listen to—and compose with—soundscape.

The critical question that has always directed my work, and which resides at the base of all my pieces is: how to solve the logical contradiction between the perfectly *organized soundscapes* of these ecosystems, which need to be experienced and displayed as they are, and my own drive for creation? The possible answer generates two more questions as I stated elsewhere: Is it possible to learn from a primary ecosystem and to interplay within the same laws that have shaped these ancient acoustic environments? Is it possible to use compositional tools to reveal and enhance configurations of species, without compromising their intrinsic equilibrium and beauty? The approach I termed "eco-acoustic composition" tries to respond to these questions.

Fragments, One Installation/Performance

Since 2002, *Fragments of Extinction* has been publicly presented at a wide array of different installations and performances, in theatres, concert venues, art galleries, outdoor public spaces, museums and research conferences.

To help the reader understand this multifaceted approach—which also offers a new approach to listening to and experiencing soundscape—let us consider a recent sound installation of *Fragments*, presented in Rome in January 2014, at the international festival Visitazioni, which was a direct evolution of the first gallery exhibition realized at 3LD—New York, for the 2006 Ear to the Earth Festival, which went on to tour extensively in diverse contexts throughout Europe and North America.

In Visitazioni, *Fragments* (duration: 45 min.) stood as a three-part work, featuring each of the project's different approaches to ecosystem presentation in succession: immersive (pure, unaltered recordings and time-lapses), exploratory (real-time visual analysis of soundscape and ecological interpretation), and creative (eco-acoustic composition and integrative performance).

There, for the first time, the recordings collected in Borneo in 2012 (Ulu Temburong and Gunung Mulu areas) and Africa in 2008 (Dzanga-Sangha's Hokou and Bai Dzanga areas) were presented in complete darkness and reproduced in full periphony. Each performance, unfolding 4 times a day, was introduced by the author. The parallelepipedal black theatre was transformed into a completely neutral venue (both visually and acoustically). The public (a maximum of 10 people at a time) entered an absolutely dark space through a darkened antechamber. Once inside, following a floor system of thin (2-5 mm) semi-fluorescent paths (Fig.20.2), each visitor was led to a central circular area, where the three-dimensional sound illusion was strongest.

Part I: The Immersive Experience

The audience eventually found itself standing within a circle, silent and invisible witnesses of an exuberant habitat of insects, amphibians, birds and mammals, pulsating from all directions. A dramatic 20-minute time-lapse of a dusk chorus of Borneo primary dipterocarp forest habitat, enveloped the listeners in the increasing density of the species' vocalizations over time, which toward the night-time usually culminates in an impressive wall of sound formed by hundreds of individual insects vocalizing from different territories. Compositionally, 2-minute sections of the unaltered, original 3-hour recording were interwoven imperceptibly in a chronological order, forming a *compressed* aural reconstruction with phenomena experienced as naturally occurring.

Except for the subtle fluorescent ellipsis connected to the *streams* on the floor, the space was so dark that keeping one's eyes open or closed created identical experiences. Darkness augmented the sonic immersion achieved through space-preservative recordings and the multichannel periphonic system, not preventing the impression of being present within the enormous, organic space of a rainforest, in a real, living ecosystem, one of the oldest (possibly 140 million years old) and most remote forests on Earth.

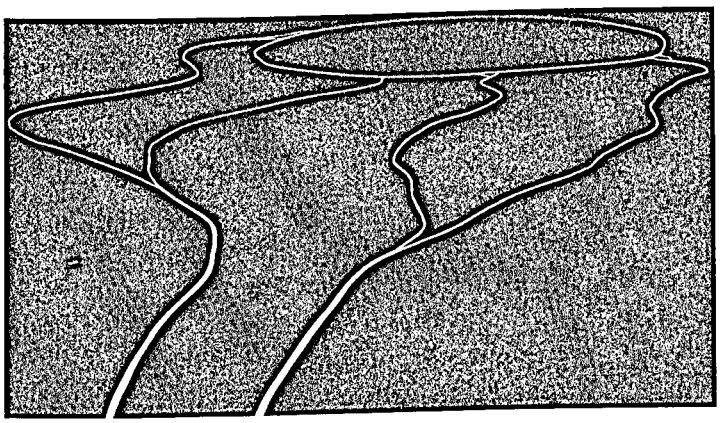


FIGURE 20.2 Long-exposure photograph of the semi-fluorescent floor paths in the 15.50 × 4.50 m venue.

Audience members spoke of a kind of *primordial* experience and, surprisingly, about the familiarity of these soundscapes, which no one present could have actually heard before.

Part II: Nature Explained

The work's second part began with the slowly fluctuating light of a real-time, high-definition spectrogram of the acoustic environment being heard. The theatre's interior was revealed, as the immersive darkness of the first act gave way to the low light of shifting projections, instantly transforming visitors' perspective from that of being part of the habitat itself to being a spectator, observing the visual representation of the environment's sound.

Indeed, the smoothly flowing, hi-def visual spectrum of the ecosystem became a medium for moving from the three-dimensional aural experience of an ancient space to a bi-dimensional *score reading* where each vocalization was displayed as a graphic gesture in time. The precise structure and hidden aesthetics of the network of inter-specific and intra-specific communication was now unveiled.

This objective, physical instrument for acoustic visualization provided an opportunity for the audience to access the organic structure of the sound environment without superimposing any didactic or narrative content, thus constituting a primitive, non-interpreted electroacoustic score of the soundscape.

The second stage of the performance now began: a 10-minute time-lapse of a 9-hour continuous recording in Africa composed of 1-min. sections starting from dusk, unfolding in both the acoustic space and in the visualizations on the wall. The recording featured a swamp forest with many species of frogs and insects forming a dense mass of dynamically shifting, narrow frequency niches, as well as a bat species with inaudible, clear echolocation bursts in a bandwidth centred at 25 kHz.

The organized texture of insects and amphibians in this recording also encompassed passages of hornbills flying in the foreground and scattered sound gestures of gorillas' chest beatings in the far background. Suddenly, the trumpeting of a forest elephant (which

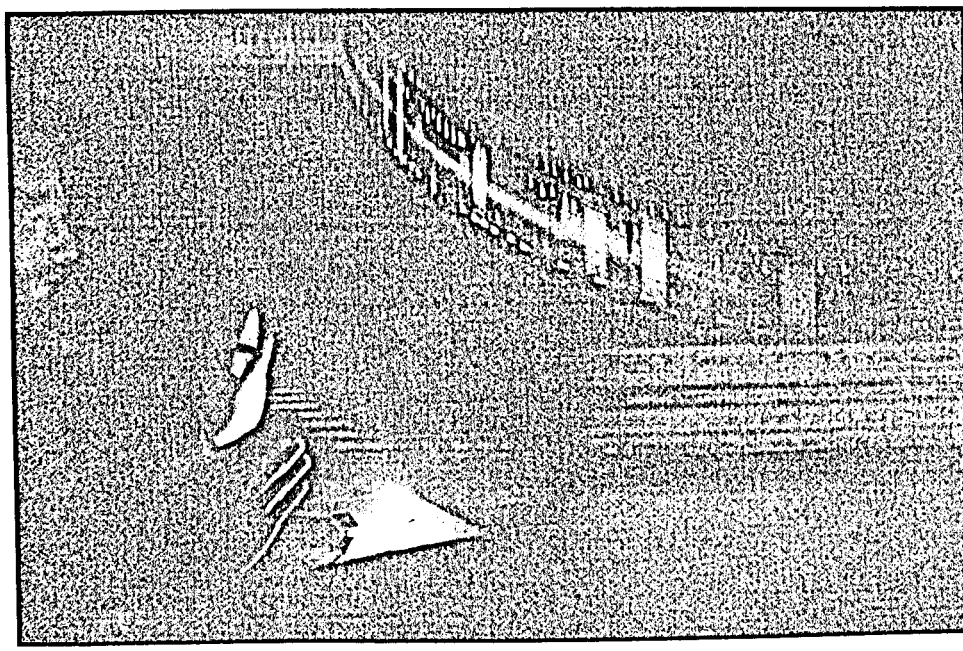


FIGURE 20.3 Visitazioni 2014. Photo of the moment in which the sensor-driven digital performance begins (opening of part III). The real-time spectrogram analysis displays insects and bats at around 18–25 kHz, progressively shifted in frequency (8-octave, logarithmic). The aim of this process of transformation was to bring the inaudible sound gestures of these animals down to an audible area, thus providing the audience with a tool to hear the inaudible world. Horizontal axis: time (depicting from right to left—about 3-min window in the photo; vertical axis: frequency (20–22 kHz); color: acoustic energy from silence (black) to about 70 dB (bright grey).

deep at night during fieldwork started to vocalize exactly below the autonomous microphone system) crossed the spectrogram, while also resonating in the aural space of the theatre. The extremely loud, low-frequency vocalizations of these large mammals (with fundamental frequencies going down to 12 Hz) and the long and diffused reverberation of the forest edges of the Bai make this recording a rare and stunning full-spectrum example of a sonic ecosystem, presented to the audience in its audio-visual form, via selected electroacoustic explorations of the sound spectrum conducted in studio (Fig. 20.3).

Part III: Nature Integrated

The third part of the work began with the entrance of a performer, stepping slowly into the space with a candle. Contrasting with the blue-dominant spectrograms, the warm candlelight, gently illuminating the performer's hands, brought a radically different atmosphere into the theatre. The real-time spectrogram shifted into an analytical/performative canvas on which the performer himself observed the habitat's structure and its niches' configuration. By means of ultrared sensors reading the subtle movements of hands, the three coordinates x-y-z of selected fingers were mapped into two different software programs for digital sound synthesis: the first one generating textural electronic elements which the performer used to build background *horizons*; the second one, based

on the prompt analysis and re-synthesis of selected sonic gestures of insects, amphibians and birds from each specific habitat—which the performer used to introduce elements within the unoccupied frequency, temporal niches and the available space in the soundfield scene. With small and very slow hand movements visible to the audience, the performer (the author, in Rome—Fig. 20.3) inserted compatible, synthetic sounds into the available space present in the visual (thus sonic) network, suggesting a possible form of interplay consistent with a composite ecosystem, without causing any disturbance to it: an ephemeral, virtual form of interspecies coexistence.

Conclusions and Current Developments

Visitazioni provided a crucial adaptation of *Fragments of Extinction* to a theatrical space, and represented the ideal circumstance for understanding the dynamics of *presence* within a virtual ecosystem. Due to the loss of any visual reference point within the installation space (absolute darkness in the first part), the impressions collected revealed that many visitors experienced the opening up of a visceral, instinctual, and deeply emotional perception of the outer 3D soundscapes. In such a space, as in dense tropical forests, the complete lack of visual information makes sound function as the only medium for the perception of distance, perspective, and orientation.

From my experience, working with environmental sound requires imagining the final context and composing its space, even before organizing the sounds. The context is always part of the aesthetic experience. While most approaches in site-specific sound art use context for generating artistic content, by its nature, *Fragments* needs an isolated and *neutral* space, capable, in the end, of transporting audiences to remote and extremely inaccessible ecosystems. Darkness, acoustic insulation/damping, symmetrical multi-speaker and video setup capabilities are mandatory. These, however, are rarely found in existing, available venues such as galleries, theatres, museums, and public spaces.

To resolve this issue, and to facilitate full audience participation, I engineered and designed the Eco-acoustic Theatre (also known as the Bio-acoustic Theatre, from its initial conception in 2005) as an ideal device for the immersive listening of ecosystems (Fig. 20.4).

This flexible venue offers a radically new experience of nature through sound and visual analyses of sound: a unique context, in which an extremely sophisticated technological experience—collective in form—gives rise to an intimate understanding of something unknown and primordial, while also being profoundly resonant and familiar. Ideally conceived as a *temple*, the theatre simultaneously constitutes a virtual space and a temporal journey back into the oldest ecosystems on Earth. The sound is either a playback of the recordings or streamed in real-time from selected rainforest habitats.

The Eco-acoustic Theatre embraces each of the three different purposes originally envisioned by *Fragments of Extinction*, described above as the immersive, exploratory, and creative compositional approaches. As happened in the installation presented in Visitazioni, the visitor is channelled through different stages of listening, with increasing degrees of intervention by the artist, so that one not only participates perceptually in the

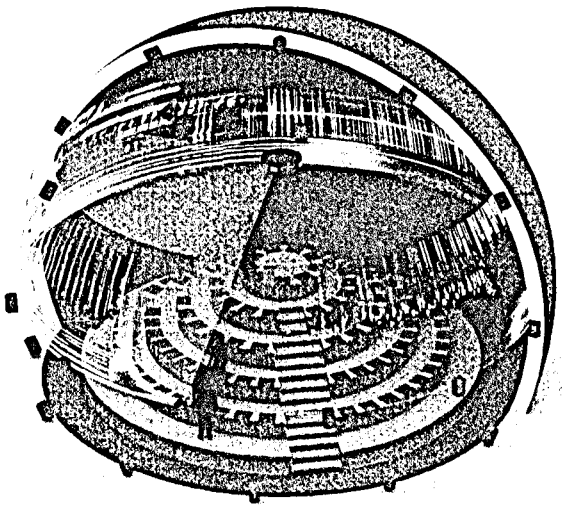


FIGURE 20.4 The Eco-acoustic Theatre (Patent 2013) by D. Monacchi. Pictured: a 12-m-diameter option (3D rendering by Pippo Marino). A prototype of the Eco-acoustic Theatre, which is also the research and production studio for the project *Fragments of Extinction*, has been built and is fully functional at the Conservatory "G.Rossini" of Pesaro, Italy.

wonder of the context, but also learns about its organization and relishes the aesthetic experience, while augmenting one's sense of connectedness with nature. In so doing, the theatre challenges the conventional divides between the different domains of virtual reality, science, and art.

Coda

Now that humanity will have to engage in a compulsory paradigm shift, from the current utilitarian view of nature to a radical eco-centric perspective, it is time to move beyond approaches which, however helpful and fascinating, incorporate natural phenomena within human-manufactured metaphoric representations, or *narrative* plots.

Fragments is an attempt toward this end, aimed at maintaining and revealing the complexity, the language and codes, and the self-contained, efficient sonic organization of ecosystems: an approach based on three-dimensional immersive experiences, where high-end research technologies for virtual acoustic reality are used to magnify the perception of the habitats, presented as they are in reality. This may open our minds to a primal aesthetic experience of the natural world, eventually fostering our inner relationship with nature and aural understanding of Earth.

Imagine silent spaces of complete darkness within the urban environment, which people enter just to experience the sounds of remote ecosystems as their 3D sonic imprint is streamed in real-time: would such meditative/cognitive activity help us reconnect with the intangible heritage and vanishing essence of the biosphere?

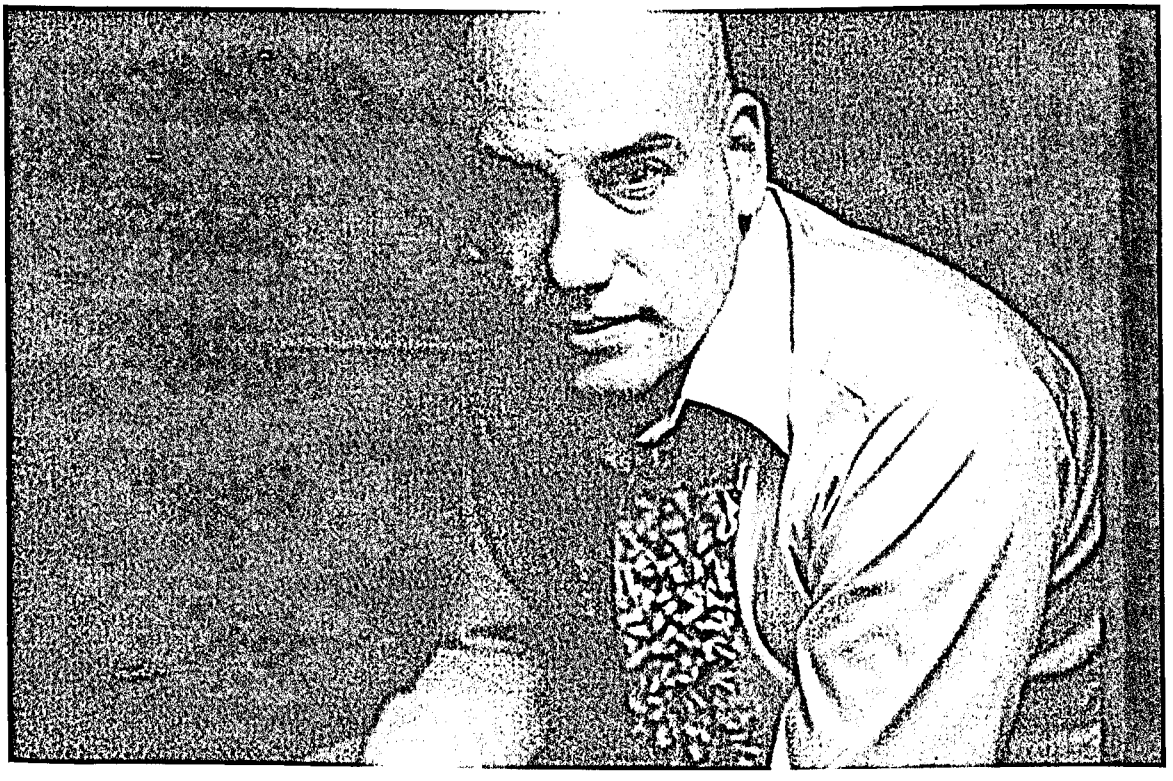


Photo by Ian Vollmer

Christopher DeLaurenti follows his microphones into unusual confluences of sound, silence, music, and speech. A maker of activist sound, his work encompasses field recordings, acousmatic music, text-sound scores, free-improvised low-tech electronics, and compositions for acoustic instruments. Because DeLaurenti's eyesight was very poor and went undiagnosed as a child, he became, by default, a sensitive listener. At the age of nine he began experimenting with tape recorders. As a teenager, he savored numbers stations and other radio anomalies on a shortwave radio. Then came the influence of punk, funk, progressive rock, politics, and, oddly enough, Harry Partch. DeLaurenti began recording his own music using unreliable gear, unstable technology, and anything else he could get his hands on. Out of those makeshift experiences he developed insightful listening strategies while acquiring heightened sensibilities to the aural world that surrounded him.

21

Towards Activist Sound

N30 Live at the WTO Protest November 30, 1999

To listen is to liberate. I start with myself by taking my microphones towards and sometimes beyond the boundaries of property, the law, and oppression. I make field recordings, but I'm not interested in *capturing* a place or building a documentary archive. When I tape small microphones to my skull, or button up a stout vest with sewn-in mics, or strap a stereo pair to my homemade mic boom, I am venturing into the world to ask "Who is heard?" "Who has?" "Who is here?" and "Why are we listening to this right now?" I ask these questions to open my ears and open my heart. Can I hear justice?

Activist Sound is one way I describe the sound pieces, performances, and installations I make from field recordings of protests, testimonies, and other pertinent sonic materials of social change. Much of my work as an artist attempts to bear witness to current crises—war, poverty, inequality, racism—which impel me to respond. I wonder how sound and listening might offer what Marcus Zagorski in his essay *Adorno's Engagement with Postwar Music* calls "a critical resistance to the existing order; the preservation of subjective freedom; and the expression of the individual before the abyss of the administered world." Does what we hear—and, crucially, how we listen—harbor the power to suspend and offer alternatives to the basic as well as complex, seemingly invisible social and political assumptions, habits, actions, and institutions which implicitly guide and control our lives? One duty of the artist is to ask impossible questions and then suggest possible answers. What I do and my purpose on this planet can be distilled into one question: Can listening save the world?

Here's how I saved myself. Growing up in alternating periods of poverty and passable prosperity, my earliest memories include palming a lunch token in the school cafeteria so I could go back for seconds. I also remember rooting through the trash for an extra pint of milk or square of cornbread. For a brief time I lived in a big house with a lovely view and a birdbath. I also skulked and cowered in neighborhoods where you

might get thrown down a flight of stairs for the hope of a dollar or a sandwich; listening to footsteps around the corner, to a dangerous voice, meant survival.

I dreamt of better worlds. My first solution, at age 9, was to build a prison. My utopian plan for the world had a silly codename, *Fenston Jackson Prison,* but after reviewing my notebook filled with laws and architectural plans four decades later, I'm surprised that at a young age I diagnosed the world's ills, including competing types of property; what I now call The Agglomerating Mass (the ever-accruing challenge to allocate worth in the accumulation of objects, processes, and people or end such accumulation altogether); the inability to rationally change modes of government (a core value of anarchism, which this callow, disdainful Marxist didn't understand until the 1990s); the illusory nature of money and debt; and the fictive (and thus liberating) sanctity of individuals and communities.

Growing up in a family of musicians nourished my utopian dreams and made life worth living. I witnessed music bringing people together and marveled at the power of sound to suspend and briefly remake a miserable environment. Almost every kind of music was everywhere. For 40 years, my grandfather rented band instruments to middle-school students. My father played jazz, pop, funk, and disco as a club and restaurant keyboardist from the late 1950s to the early 1990s; my maternal uncle was a bassist in Congolese composer Manu Dibango's band in the wake of *Soul Makossa* climbing the Top 40 chart in the early 1970s. I still remember arguing with him about the right tempo for clapping the intro to *Car Wash* by Rose Royce. My first stepmother sang on Don Ellis' wrongly maligned LP *Underground,* and my first stepfather was active in the Seattle Folklore Society, so I heard lots of Cajun and Bluegrass. Multiple marriages do have benefits!

Music, or at least my own often frustrated and frail impulse to make music, suffused my childhood. I was invariably asked two questions in succession "What's your name?" and "What instrument do you play? Every genre and style at once offered freedom as well as tyranny. "No downbeat on the one!" still echoes from an early and futile music lesson. In sound, I heard the material world of (my own) want, power, and desire. Yet I treasure my childhood and harbor no envy, no regrets, for I learned to dream in sound. The only instrument I could play—my only avenue to freedom—was to listen and imagine music as I thought music should be.

Like many artists, I began by making the work of others. I began experimenting with tape recorders when I was 9, making homemade variety show radio programs by holding down the Pause button to insert skits, songs, and rants. I adored local radio, mainly experimental music broadcast by KRAB, a freeform Seattle FM radio station, as well as CBS Radio Mystery Theater, which aired late at night. As a teenager, I savored chattering numbers stations and propaganda (Voice of America, Radio Havana, Radio Moscow) via shortwave radio and then delved into punk, progressive rock, and *The World of Harry Partch* album. Then my life began anew. After my grandfather died in 1986, I inherited a Noah's Ark of his instruments (violins, trumpets, trombone, banjo, and too much more to list) along with out-of-fashion stuff my father had decided to haul to the

City Dump, including a reel-to-reel tape deck, wah-wah and other effects pedals, battered microphones all gummed up and sticky with electrical tape, and a Moog synthesizer.

"You really want this pile of junk?" my father asked while the two of us filled a truck with the Moog, a Kustom PA, a home-built amplifier housed in a Corona Regal cigar box, acres of audio cables, and some old LPs. This might be hard to believe, but in the 1980s, the millennial era of the compact disc, LPs had aged into cumbersome relics. Monophonic analog synthesizers were well-nigh worthless; everyone coveted the Yamaha DX-7 and its digital ilk. My dad wanted to be done with music technology, "everything goes" he declared, "except the piano."

I didn't keep everything. I still mourn the home-built refrigerator-sized speaker cabinet we risked our necks and aching lower backs to shove up onto the flatbed. Yet I kept enough to follow the example of Harry Partch, assembling my own orchestra and transmuting the sound and instruments of my environment into music. Grandpa's instruments were dented, missing strings, squeaking, and dappled with rust and mold. Most cables didn't work or had to be twisted and taped down in order to pass a signal. I welcomed line hum and static into my music. Instead of faders, my mixer sported antique dials fat enough to grab and twist while playing an instrument. Erratic tape speed transfigured every recording into a miracle. I didn't know it at the time, but grappling with unpredictable equipment and haphazard, uncontrolled conditions suggested the first important lesson I learned making field recordings: The *field* is not *where*, but *how*.

Textbooks tell you that studio recording transpires under controlled conditions in a fixed space with reliable equipment, usually, according to the accompanying photos, at substantial expense. By contrast, field recordings exude the romance of travel and discovery, where scholars tramp beyond the hills to plant a microphone in front of unheard folk musicians; or intrepid scientists cart expensive and arcane equipment through mist-crowned forests to putatively blank spaces on a map. Don't believe any of it.

After college, I fell for the false romance of field recording while doing sound design and miscellaneous audio projects amid Seattle's dot.com boom of the 1990s. What was I, a child of the city, doing in the forest attempting to record birds? My feeble imitations of Bernie Krause, Irv Teibel (maker of the famed *Environments* series of LPs), Dan Gibson, and others unwittingly conformed to what Lisa Gitelman in *Always Already New: Media History and the Data of Culture* describes as "a tendency to naturalize or essentialize media," by accepting a history and purpose that might not be your own.

In 1997, I found my own forest and re-learned the hard way that the *field* is not *where*, but *how*—how you respond to unstable conditions. Outside, the soundscape may change radically at any moment; in most studios, it seldom rains or gets windy. The chief challenge of the field is how you respond to what you hear. The field is where you can foster a different way of listening and being in the world.

Inspired by the speech-music of Harry Partch, hip-hop, and *Happily Ever After* by Randy Hostetler in tandem with other works I discovered as a radio DJ including *A Sound Map of the Hudson River* by Annea Lockwood and Hildegard Westerkamp's

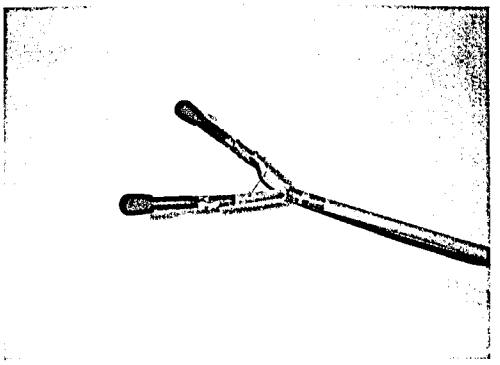


FIGURE 21.1 Home-made microphone boom. (Photo by Christopher DeLaurenti)

Kits Beach Soundwalk, I ventured into the streets of Seattle and asked random strangers to say the word "cocaine." Supplied with a computer and sound editing software by a visionary and generous employer, I edited voices and the obbligato of passing vehicles as well as overt indications of my technical incompetence (wind, mic handling noise, erratic stereo image) into an ear-popping mosaic aptly title *cocaine*.

In the city it feels right to carry a microphone, for no ear can take it all in. "The ear selects, you see, dear. Machines don't," writes John Le Carré in *The Little Drummer Girl*. Trying to capture the polyphony of voices, squealing bus brakes, and polyglot murmuring of passersby taught me that the ear is not a microphone, nor is the microphone an ear, but a parallel way of listening by magnifying and focusing sound.

Listening telescopes distance. Albert Bregman explains in *Auditory Scene Analysis*, "... sounds go around corners. Low-frequency sound bends around an obstruction while higher frequency sound bounces around it." Bregman adds that unlike reflected light which loses its shape, when listening, we can "... discover the time and frequency pattern of the source, not its spatial shape, and much of this information is retained even when it bends or bounces around the corner."

Recording can heighten the senses and prompt an unusual empathy, where you hear with two disparate sets of ears—your own and your headphones, though monitoring is not listening. You are not only recording events, but relationships among objects and living things. Listening can dematerialize the material and connect the disconnected. "The auditory world," concludes Bregman, "is like the visual world would be if all objects were very, very transparent and glowed in sputters and starts by their own light, as well as reflecting the light of their neighbors."

An hour after dawn on November 30, 1999 I rode the Seattle downtown express bus to record the tens of thousands of people protesting the ministerial meeting of the World Trade Organization, a transnational governmental body convened to streamline trade agreements, labor standards, and generally grease the rails for multinational corporations to do business across international borders with as little fuss as possible. Of the many standards adopted by the WTO, not one has had anything to do with a transnational,

universal living wage, or uniform, immediately enforceable environmental protection. I wish I could say I immediately connected the ability of sound to bridge distances and bypass conceptual boundaries with humanity's dire need for an analogous transgression and transcendence of property, law, and debt. But I learned this lesson only by making *N30: Live at the WTO Protest, November 30, 1999.*

N30 begins with a crudely quick fade in towards an amplified voice asking "What the hell are you doing?" followed by several seconds of silence, and distant cheers cocooned in an unpromising burst of wind. This initial amplified voice is one of many instances of dual (or more precisely "polyvalent") address. The absence of ordinary street sounds might imply that the voice embodies what seems to be the attitude of passersby; it does however foreshadow the uncertainty amid the marchers and the dismissive, mocking (and later hectoring) tone of law enforcement heard later in the piece. These forms of polyvalent address appear in multiple guises throughout the work, notably when a young man slithers into a pompous BBC announcer's accent to deliver a mocking eulogy for *N30* while an evangelizing nasal voice quotes the Book of Matthew and invokes James Joyce, "Let the dead bury the dead."

"What the hell are you doing?" addresses me too, kneading and bruising my own bagful of doubts while underscoring the inclusion of elements unwelcome in field recording and location sound: distortion, wind, off-axis (i.e. jarringly muffled) sound, which since 1997 I had employed to frame and propel my pieces recorded on the streets. These lo-fi traits function similarly to Brecht's distancing or alienation effect, reminding listeners that *N30* is a construction by explicitly flouting the fidelity expected by listeners raised on radio and professional recordings.

In her essay *Contradicting Media: Toward A Political Phenomenology of Listening,* Jody Berland declares that radio has a "rational irrationality" and an "... ability to place together sound messages that are disparate in terms of their location of origin, their cultural purpose, and their form, in order to create an enveloping rhythm of sound and information." This rhythm, she concludes, "... is about the market," which I did not want for *N30.* Like most field recordings, it was mine to share, not to own. Although sold for a brief time (2000–2004) on a compact disc, *N30* has always been a free mp3 on the web.

To further disrupt any market rhythms reminiscent of radio, the lo-fi elements at the start of *N30* gradually molt, revealing recordings of increasing fidelity. To maintain the quasi-distancing effect, I framed sections of *N30* with the following silences: 7 seconds at 06" and 3'26"; 4 seconds at 9'20"; 2 seconds at 9'36" and 9'45"; 7 seconds at 49'31"; 13 seconds at 50'33"; 3 seconds at 52'02"; and 4 seconds at 59'25" (the piece concludes at 61'28"). These silences—verboten *dead air* in radio parlance—frame various sections, building tension from one part to the next as well as serving as an invisible narrator, shifting the listener's attention from one aspect of the soundscape to another location, fidelity, or emotional viewpoint.

There are no names in *N30.* Only in your mind's ear and eye can you discern what is happening. According to one voice, there are people in the street. A yelping female

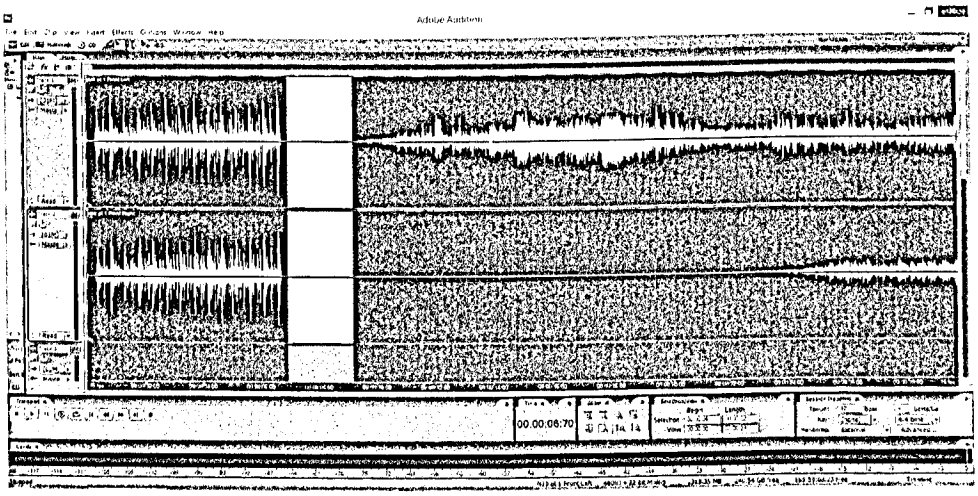


FIGURE 21.2 First silent section of *N30*.

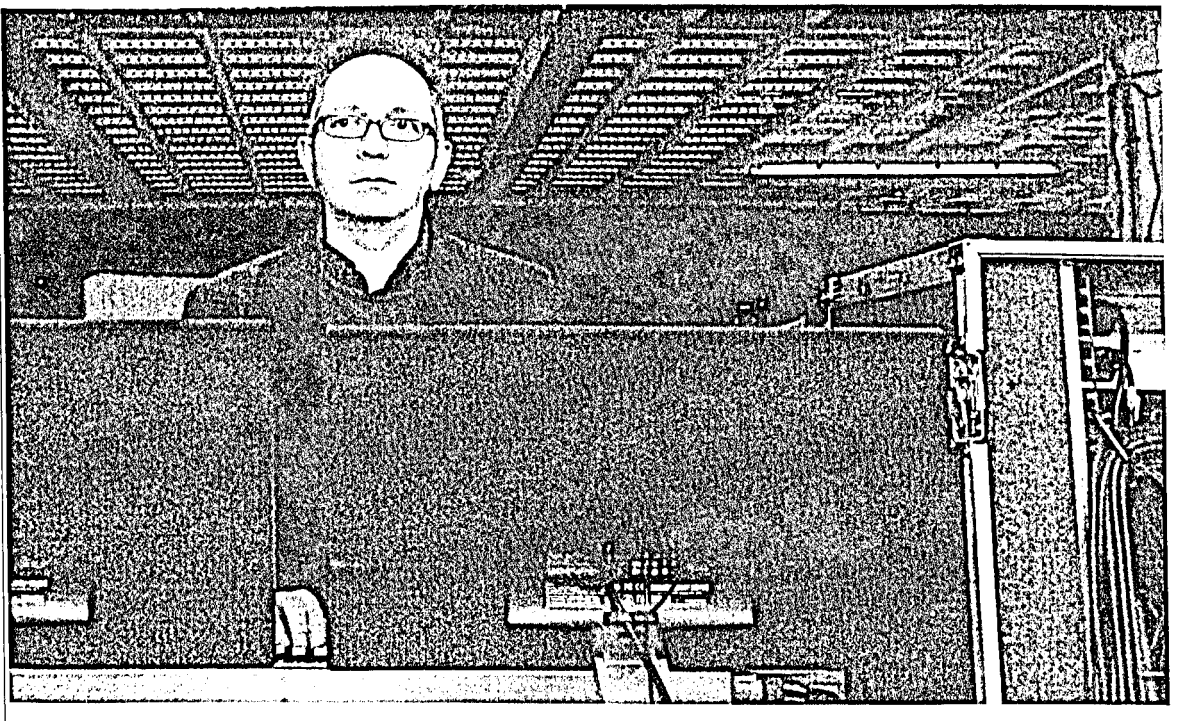
voice warns of the impending arrival of "the cops." They may appear, at least a different set of voices show up. But what permeates this soundscape is an unmistakable polyphonic web of voices. "It ain't worth it," "Don't tread on me," "I saw you hit that girl ..." And of course screams, and "I'm not your fucking enemy." Any shouted slogans neither supply additional facts or nor explain the original impetus of the protest. Note that the slogans were repeated, re-said without loop-like repetition; each voice responded and reacted uniquely to a particular micro-crisis (physical harm, imminent arrest) as well as to the original impetus of the protest. We hear what from a distance may seem like a chaotic soundscape, of a kind we seldom find: polyphonic, heterophonic with a range and type of voices largely absent from television, movies, or radio. Crucially, what may seem like chaos turns out to be *soniferous garden* of protest, dissent, and liberty.

Sound, language, and music elide in *N30*. The martial tattoos and scattershot polyrhythms drummed by the Infernal Noise Brigade evoke a high-school pep band jamming with the Burundi drummers. Chants of "There's no power like the power of the people 'cause the power of the people won't stop" and "Hey hey ho ho WTO's got to go" ripple through the crowd. The unpredictable ebb and flow of the chants add, I think, to the sonic splendor. Between the walls of downtown Seattle's cavernous buildings, the echoing drums, colliding with the distant drums behind and in the vanguard, summon a new, specifically urban, thunder. I now understand Charles Ives' revelation of hearing two brass bands marching from opposite ends of town toward each other.

A few weeks after composing *N30,* I sketched possible liner notes which began by suggesting "....explication implies self-importance, so the very presence of the following paragraphs may imply that my WTO field recording is of value, but let me emphasize that it may be a failure. I believe all composers carry the burden of failure, which is best summarized by aphorism XIII from *AMMMusic 1966*: "There is no certain knowledge, in relation to your development that the effort you are making at the time is the right effort."

In *N30* do you hear the sound of freedom or social destruction (along with some negligible vandalism)? Or is it just the sound of people yelling and beating drums? In her introduction to the German translation of *Tuning of the World*, Sabine Breitsameter summarizes R. Murray Schafer's political critique inherent in his concept of the soundscape: "Any soundscape's manifestation points to the natural, cultural, technical, and social conditions of a society and refers back, then to the latter's priorities, deficits and power structures."

Despite a young woman's hurried and breathless attempt to explain "If the WTO passes ...," there are no ideas made didactically explicit in *N30* because the protestors had to fight to be merely present, to defy the idea that property trumps public gathering, movement, presence, discussion, dissent. I define politics as the collusion and collision of personal and collective power; I hope the raw political soundscape of *N30* not only serves as a document, but an invitation. Only you can free your ears: Your heart, your mind, might follow.



Aki Pasoulas is an electroacoustic composer interested in acousmatic music, time and timescale perception, psychoacoustics and sound perception, spatial sound, acoustic communication, and soundscape ecology. He has organized and performed with diverse ensembles using material ranging from minimalism and post-punk to experimental music with vocal utterances, acoustic instruments, found objects, electroacoustic improvisations, mixed works, and acousmatic compositions. His work is strongly influenced by the power inherent in sounds. This power resides in the ability of a sound to provoke memories, trigger involuntary responses, and to evoke the past. As an artist, Pasoulas handles these sonic elements and integrates them into his musical compositions with confidence, insight, and intuition. Like a classical composer expertly handling the intricacies and details of counterpoint, Pasoulas has fully internalized and skillfully deployed his expanded sonic pallet.

Aki Pasoulas is a Lecturer in Music and Audio Arts and the Director of MAAST (Music & Audio Arts Sound Theatre) at the University of Kent. He holds a PhD in timescale perception in electroacoustic music, and between 2004 and 2012 he taught at universities in London including City, Middlesex, and the University of the Arts.

22

The Listening Experience of *Paramnesia*

It was a typical warm afternoon in the middle of summer and I was strolling along one of the narrow streets of Montpellier in the south of France. Little gift shops for tourists were interchanged with grocery stores and boulangeries, and the aroma of freshly baked baguettes and croissants hit my nose at irregular intervals. Now and then, a motorbike broke the continuation of the generally quiet sounds of the city at that particular time of day. Suddenly, out of nowhere, I heard a very familiar sound; regular short beeps in quick succession which lasted only a few seconds. I did not know where that sound came from, and I was not concerned about its source; but part of my self woke up with a vivid response. Momentarily, I was mentally transferred to London where I spent many years and still visit frequently, in particular to the London Underground at the time when the train doors are about to close. My eyes instinctively looked for the doors—am I getting on or off the train?

Sounds have the power to wake memories; they may trigger involuntary responses or evoke feelings depending on our past experiences. Since I started working with electroacoustic music, in particular acousmatic music where visual information is somewhat suppressed, I became interested in and later fascinated by the influence recognisable sound shapes and other sonic characteristics have on our interpretation of the surrounding world, and by extension on our experience of music. My continuous research on spatiotemporal dynamics and extra-musical associations of sound events led me to seek deeper relationships between sounds, structures and time perception.

I would like to discuss *Paramnesia*, which is a stereo acousmatic piece, i.e. designed for loudspeaker playback, composed in 2008 and 2009. The piece was created as part of my doctoral research at City University in London, and it was partly funded by the CRiSAP research centre (Creative Research into Sound Arts Practice). By revisiting the composition, I hope to let my thought processes unfold for the reader and reveal my motives and rationale. *Paramnesia* covers a wide range of temporal processes and practices related to time perception. I will concentrate on the use and reasons for using environmental sounds, highlighting temporal operations where applicable. I do not consider myself exclusively an environmental sound artist; however, my practice as a composer

often involves sounds from our surrounding environment, for reasons that will become clear in this text.

A great part of the composing process for *Paramnesia* involved soundwalks and attentive listening, even before I started recording, or even thinking about the basic structure of the piece. The initial inspiration came from the environment, or rather from various settings, scenes and spaces I had been experiencing while practicing attentive listening—i.e. paying attention to sounds of all perceptible dynamic levels and to subtle changes at both proximal and distal spaces.

Paramnesia

The composition consists of two connected movements, *Promenade* and *Repose*. The word *paramnesia* derives from the Greek *παρά* and *μνήμη* meaning *near* and *memory* respectively, and is a condition that causes confusion between reality and fantasy, resulting in distorted memory. People who suffer from paramnesia fabricate imaginary events to compensate for loss of memory, and they also experience déjà vu. Imaginary events, reality and fantasy, visits to childhood memories distorted by the passage of time, and impressions of events reoccurring are themes that are explored in *Paramnesia* both musically and through extra-musical association.

The first movement of my composition is called *Promenade* and represents daytime, whereas the second movement *Repose*, represents night. Although day is usually associated with liveliness whereas night is mostly seen as its opposite connoting tranquillity, the composition employs energetic and calm sections in both movements. Events from my environmental recordings are taken out of their original context and re-assembled, so that there is no story unfolding apart from the distinction between day and night. Sounds of nocturnal creatures were, for example, heavily processed or imitated using diverse material to assemble sound shapes (also known as spectromorphologies) needed for the night scenes, whereas human activity permeated the day scenes. The climactic section of *Promenade* is inundated with cars, seen in the composition as the epitome of human activity. The sound of the cars gradually distorts and changes into agitated violin chords that form a bridge between *Promenade* and *Repose* and eventually disappear in the night setting. Later in *Repose*, nocturnal tranquillity is replaced by busyness that fades out near the end to reveal the return of human activity manifested by the occasional car, which may be interpreted as the ending of the night.

In *Paramnesia*, the environmental recording process concentrated on gathering sounds that best represented the periods of day and night. The recorded sounds I decided to keep and use in the composition presented some interest in their morphological development and also in the way that frequencies evolved and progressed within each individual sound event. As a composer, I seek musical relationships in the tiniest fragment of time, as well as within longer timescales. I usually look for sonic richness, which sometimes necessitates the addition of content until a level of richness is achieved. I tend to work with discrete events rather than entire soundscapes, as this gives me high flexibility

when constructing environments as close as possible to the scenes I imagine. However, sometimes something unexpected may appear while bringing events together; relationships may form that would not exist in the real world, but which forge musically or contextually interesting patterns and combinations. The use of abstraction and the creation of personal, rather impressionistic interpretation of sound worlds are keys to my practice as a composer. However, the interpretation of those sound worlds by the listener largely depends upon their own autobiographical experiences; this is where the use of recognisable sounds and their associations become very important.

As anyone who records environmental sound probably knows, it is very difficult to separate individual events from their environment. To achieve that, I use software where I can isolate particular frequencies, and then copy and paste those selected sound events into a new file. This is said easier than done, especially when sound events do not have a definite pitch, and peaks of energy in the spectrum are not clear. In addition to that, while sounds may be separated from their surrounding events, they can never be disconnected from the space in which they were originally recorded; each sound carries within it the space in which it once belonged, and which manifests itself through various spatial characteristics—such as reverberant quality and distance between the sound source and the microphone. Imagine a choir in a church. How can a choral performance be separated from the reverberant characteristics of that space? I was confronted with similar concerns while composing *Paramnesia*, and the solution was to use spaces constructively. Spatial characteristics were brought together through sound events that occurred in similar spaces. Sometimes, an event or group of events with different characteristics was injected into an established space to form a window into a different sonic environment.

In addition to the creation of diverse acoustic spaces, *Paramnesia* explores disturbance of chronological order by employing recurring passages or gestures which are disguised in different forms, thus attempting to portray experiences of déjà vu. The piece also explores the potential of recognisable events to suggest temporal information taken from the original environment of their recordings; for example, the ambience of a working day in an office suggests daytime, and the hoot of an owl in an open space suggest night. Furthermore, *Paramnesia* considers temporal information which can be imparted through the pace and momentum implied by extra-musical associations. For example, the combination of a whooshing sound, a percussive thud and a shout may refer to a specific event when played in quick succession; we may interpret the arising event as a person hit by an object or a punch. Our interpretation is likely to be based on associations made with action movies or video games. The spatiotemporal trajectory created by the perceived event implies a space proportional to a human, whereas the momentum involved emphasises the suddenness of the gesture.

Daytime in *Promenade*

The first movement, *Promenade*, is based on a recording made in the promenade of Alghero in Sardinia, which provided much of the associative material needed for the composition.

Daytime is suggested by the sources and the causes of sound events. Day scenes involve human activity, which usually takes place during daytime—especially activity involving children. Voices of children playing were layered with exaggerated gestures of rolling balls to create a playful atmosphere. Conversations were cut into smaller segments, superimposed to become mostly unintelligible; thus, attention is drawn to human presence, but away from any subject matter existing in the dialogue. (Note that the recorded conversations are in the Italian language, which also makes fragmented sentences unintelligible to the non-Italian speaking audiences.) Additional sounds that imply presence of people include footsteps, cars, motorcycles, and a horse-drawn carriage.

Non-associative sounds can become part of a soundscape where a strong temporal identity is already established (e.g. morning), while they may also heighten the impression of a particular setting. For example, the rolling sounds heard early in the first movement do not carry any specific associations if played alone, but as they are mixed with children's voices, they integrate into the soundscape acquiring an almost playful character as if they were sounds of toys. A little later, rolling gestures in lower pitch are mixed with squeaky sounds from a cart and the clatter of the horse's hooves, emphasising the circular motion of the wheels, and thus acquiring a different possible meaning; they evoke the cart's wheels as they drag on the road.

The high energy implied by the established temporal setting (day) gradually grows and culminates in the first climactic section. Heightened tension is created from the combination of the density of the passage, the persistence of a violin chord, and the spatial animation of the cars' trajectories which are contrasted with the relatively stable spatial image of the violins. Musical tension is supported by the liveliness suggested from extra-musical associations with busy street scenes and with mental images of physically active violin performers. Successive associations create connotational chains, which emphasise

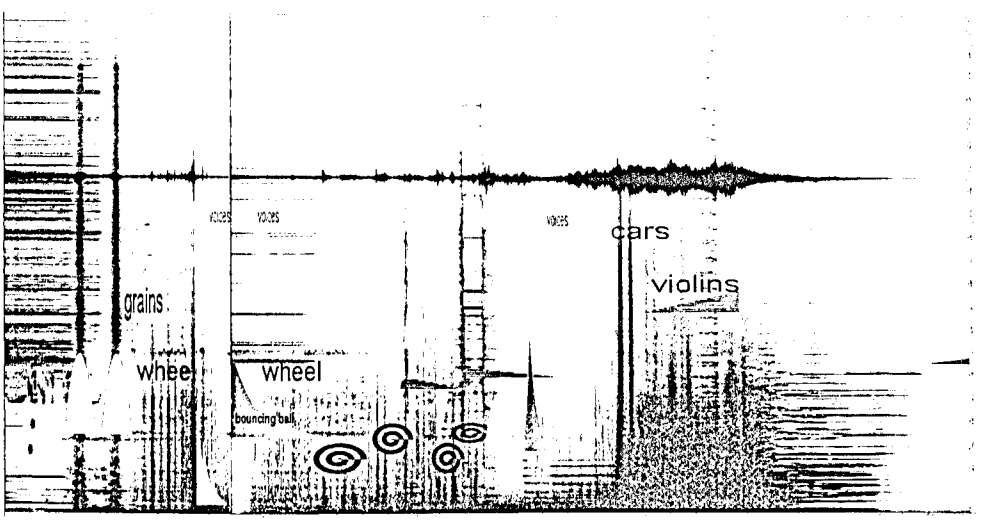


FIGURE 22.1 Diffusion score for *Paramnesia*, first movement.

the briskness of the scene; dense traffic implies day, which in turn connotes a period of light, wakefulness and busy activity that underline the high energy of that section. The first movement finally resolves in a long fade-out of groups of frequencies emanated from cars and violins, connoting relaxation and reconciliation.

Night-time in *Repose*

The transitional section of a prolonged texture that consists of slowly disappearing thin spectral layers connects *Promenade* with the second movement *Repose*. Vestiges of cars and violins gradually change into a superimposition of long thin layers of partials that move at different rates, until they become stable, merge together and fade, finally integrating with an imaginary night scene.

Spectromorphologies of unrecognisable and ambiguous sounds become part of the night scene, because they are framed between other sounds created to resemble screeches of nocturnal birds. For example, at the very start of *Repose* we hear what appears to be the cry of a night bird that eventually flies away from the scene towards the edge of the panoramic space. Apart from very few conspicuous sounds that carry temporal associations (i.e. night), sources and causes of gestural and textural material are rarely apparent because they play with ambiguity and so liberate the imagination of the listener. Extra-musical mental connections appear intermittently from uncertain sources. For example, there are events which may be interpreted as sounds of passing cars or fragments of sweeping broadband noise. There is also a continuous iterative texture which can be heard as an insect, a night bird, a synthesised or a recorded pulsating periodic sound. However, the listener is guided through preceding material (night birds) to hear connections between the iterative texture and nocturnal creatures, thus reaffirming the sense of night-time.

The temporal setting of night is further emphasised by a lack of human activity, which contrasts with the prevailing human presence in the first movement, *Promenade*. Associative sounds carry spatial references, although these are not always explicit, especially when the sources and causes of those sound events are ambiguous. If one hears the sweeping noises which appear at different moments in the second movement as cars moving at a distance, the distal space is pushed further back and away from the position of the listener because the gesture associates with past aural experiences and real-world images. In addition, the limits of the panoramic space might broaden because a wide horizon can be evoked as a result of extra-musical associations. Real-world sounds awake memories of spaces and spatial motions, and in this way they can reconstruct the space around the listener. Although, to an extent, this can be achieved by digital signal processing techniques, spaces created through association are hard to break. Imagine the sound of waves; no matter how willing we may be, when we hear their sound, we can never visualise waves crashing into an enclosed space; they always sound outside in the open—the mental image is hard to defeat. Attention was paid to the way sound events

behave spatially, always taking into account spaces that arise from extra-musical associations.

Elsewhere in the second movement of *Paramnesia*, a periodic repetition of a bell sound heard over a bubbling texture of predominantly low frequencies offers tranquillity to the nocturnal scene, and also serves as a bridge between the calm section of the second movement and the climactic part that follows it.

The climax of *Repose* is reached through an accelerated rhythm that ends up in irregular beats before the space opens up with a large swelling gesture. Even in its peak, the night scene does not include fast rhythmic figures, but instead uses concurrent pulsating streams of sounds and slowly moving textures, thus creating a complex superimposition of spectromorphologies. Night is generally associated with tranquility because it has invariably been the time of rest and sleep for humans, as little activity can take place in the dark. In this climactic section, structural tension is used in contrast to connotational tranquility. Interestingly, in this case, structural tension prevails and wins attention because it overwhelms the scene, and so tranquil associations become insignificant and fade. The tense nocturnal scene attempts to overwhelm the senses by incorporating several auditory streams that develop at the same time, each involving various changes from the micro to the macro level. Such sections, with entangled lines and planes, create spectromorphological and rhythmic complexities, which invite further listening to disentangle them, if possible, by shifting attention and hopping among layers of sounds.

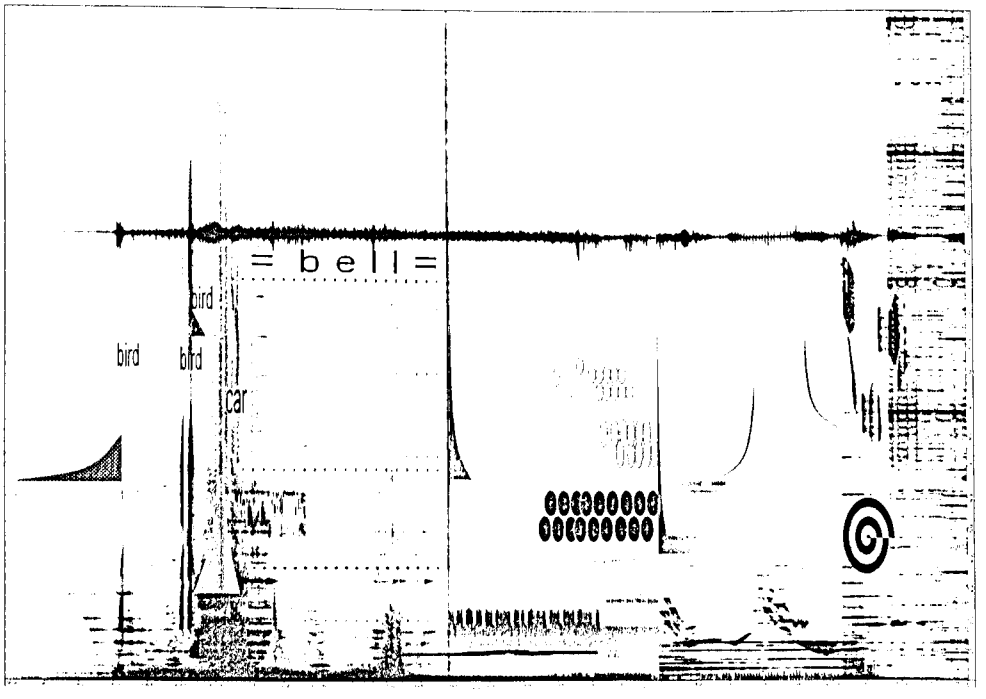


FIGURE 22.2 Diffusion score for *Paramnesia*, second movement, part one.

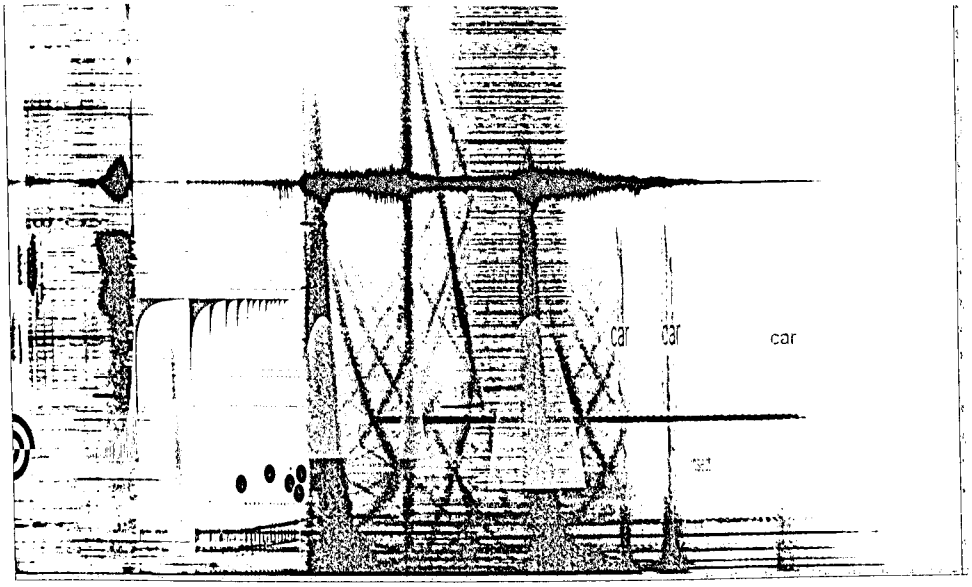


FIGURE 22.3 Diffusion score for *Paramnesia*, second movement, part two.

Flashbacks

In *Paramnesia*, events are rearranged throughout the composition so they introduce flashbacks of previously heard material, suggesting experiences of déjà vu which are connected with the condition of paramnesia. Gestures are disguised in different forms, bearing some degree of resemblance to their earlier shapes. A swelling gesture, for example, appears a few times in both movements, which is morphologically very similar to the passing car heard at various moments in the piece. Even though durations of the swelling gestures and the passing cars are not identical, their general shape and spatial motion bear close resemblance, so that sometimes they evoke each other.

It is inevitable that there are different degrees of recognisability which depend on the attentiveness of the listener and familiarity with the work. Repeated listenings make it easier to recognise disguised and distanced recurrences, although some of them are easily noticeable from the first listening for various reasons, which include contrast with the surrounding sounds, and prominent position in the piece.

There are particular moments in *Repose* where the listener is taken back to *Promenade*. Although not as intricate as some other pieces that explore recurrences (like Dhomont's *Cycle du Son*), *Paramnesia*'s flashbacks attempt to disturb the order of events in the mind of the listener by bringing memories of the day scenes into the nocturnal setting. Moreover, it is ensured that the importance of those events is established by using enough recurrences in the first movement before the flashbacks are introduced in *Repose*.

Cadence

The important connection between spectromorphological development and environmental sounds in *Paramnesia* has been made explicit; their essential interconnection characterises the harmonious relationship between all the elements that constitute the composition. The gestures and textures emerging in environmental sounds operate closely with synthesized and processed material, emphasising behaviours and meanings.

When looking back, the reaction from critics belonging to either electroacoustic music or environmental sound practice was very positive. *Paramnesia* was shortlisted at the Concours Internationaux 2009 in Bourges, France, and was selected for performances in many events, including the Sonic Artists in Wales electroacoustic symposium in Cardiff, the RedSonic Festival in London, the International Computer Music Conference 2010 in New York, the Electronic Spring festival 2010 in Vienna, the Festival Futura 2011 in Crest, France, the Emufest 2011 in Rome, and the WFAE 2011 International Conference on Acoustic Ecology in Corfu. The composition was one of the seven pieces (among hundreds of submissions) chosen for the ICMC 2010 CD, published by the International Computer Music Association.

Paramnesia neither seeks to promote environmental sound awareness like many especially early soundscape compositions do, nor is focused explicitly on environmental sound sources. However, this composition is a celebration of the richness of the sounds

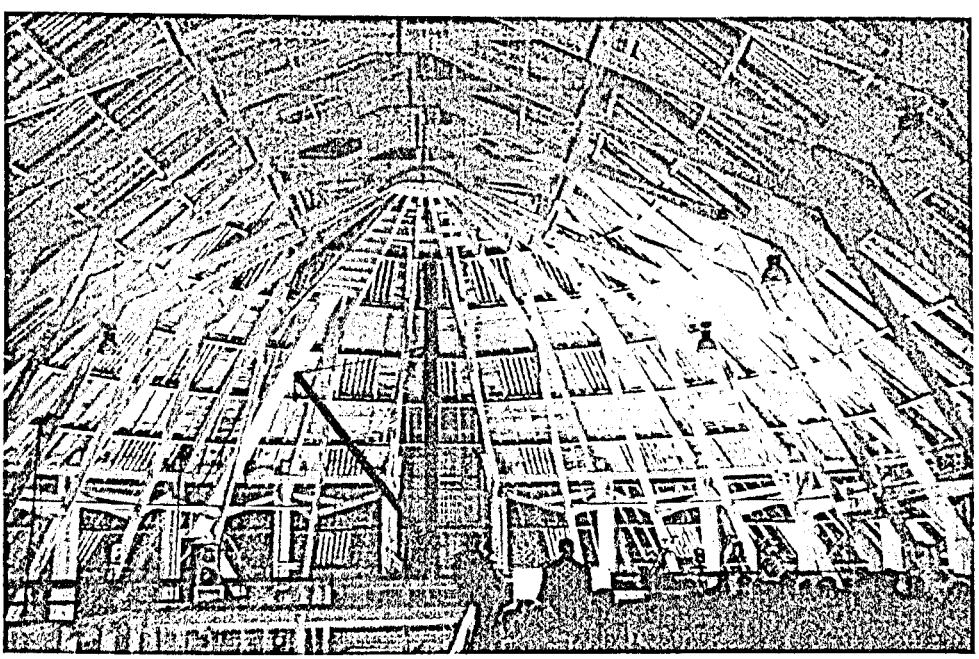


FIGURE 22.4 Diffusing *Paramnesia* in the Symposium on Acoustic Ecology 2013 at the University of Kent, using the Music & Audio Arts Sound Theatre (MAAST) system with 32 loudspeakers.

that surround us and the power of their associations. In the same way that sounds transferred me instantly from the streets of Montpellier to the London Underground, recordings of recognisable sound images take us out of our listening spaces and away into the deep recesses of our memories. *Paramnesia* is about the marriage of environmental sound with spectromorphological thought, perception and interpretation, composing and listening.

Photo by Robert Hillmann

Matthew Burtner is a composer and sound artist specializing in concert chamber music and interactive new media. His work explores ecoacoustics, embodiment, and extended polymetric and noise-based systems. Burtner's instrumental and electroacoustic music draws environment into the musical structure and attempts to decentralize human notions of time and form, searching for more universal and ecology-centered forms. He credits the fierce and noisy sounds of the Alaskan wilderness as a major influence in his creative work. Nature impressed him far more than any human music, and so he sought a way to bring the fundamental systems of the natural world into music. Through his music and environmental sound art, he seeks to create a symbiotic human–nature aesthetic by bridging creativity and environment. In this pursuit, Burtner founded and directed the nonprofit environmental arts organization EcoSono, a collective of environmentalists, musicians, and artists working for environmental sustainability and human creativity in collaboration with nature.

Born and raised in Alaska, Burtner is First Prize Winner of the Musica Nova International Electroacoustic Music Competition, an IDEA Award winner, and an NEA Art Works Grant winner. He is Professor of Composition and Computer Technologies (CCT) at the University of Virginia.

23

Musical Heuristics in *Six Ecoacoustic Quintets*

Through my music and sound art, I seek to create a symbiotic human-nature aesthetic by bridging creativity and environment. My work brings natural systems into the realm of music, and pushes musical aesthetics towards the noise and temporality of nature. As a child growing up on the coast of Alaska's Arctic Ocean, on the southwest coast of the Bering Sea, and in the Chugach Mountains, I learned from my family to live in close collaboration with nature. The fierce and noisy sounds of the Alaskan wilderness impressed me far more than any human music, and so I sought a way to bring the fundamental systems of the natural world into music. I was inspired by composers such as Iannis Xenakis and Barry Truax who used technology to model the mathematics of nature into musical forms. I studied computer music at Xenakis' studios in Paris and worked at Truax's studios in Vancouver. Meanwhile, I pursued academic studies in music composition, computer music and philosophy at Stanford University, Johns Hopkins' Peabody Conservatory, Tulane University and St. Johns College. I developed an approach that has become known as *Ecoacoustics,* a method of musical human-nature dialectics incorporating computational sonification and interactive acoustics. My works *Fern* (1996) for computer sound, *Mists* (1996) for stones and noise, *Sikuigvik (Time of Ice Melting)* (1998) for piano and large ensemble, and *Tingnikvik* (1999) for ensemble and computer sound, were formative in the development of this approach. My pieces such as *Syntax of Snow* (2010), *Sonic Physiography of a Time-Stretched Glacier* (2014), *Six Ecoacoustic Quintets* (2010) and *Auksalaq* (2012) take on the devastating effects of global warming on my home.

Most of my music is intended for live, staged performance. I often collaborate with choreographers, videographers, architects, scientists and poets to build performances that incorporate intermedia, spatial design and scientific discourse. My large-scale staged ecoacoustic works *Ukiuq Tulugaq (Winter Raven)* (2002), *Kuik* (2006), *Auksalaq* (2010), and *Deep Earth* (2014) are examples of this approach. I am interested in how human imagination becomes embodied through environment, and so my music often involves emerging tools such as distance technology, social networking synthesis and spatialization in combination with human performers. *Spectral Shift of a Distance Form (2014)* for

saxophone distance cello ensemble and computer, *Golden Sparrow* (2012) for distance trumpet and computer sound, and *Ecoacoustic Concerto (Eagle Rock) (2015)* for two trumpets, large ensemble and ecoacoustics explore this approach to distributed live performance.

I currently split my time between Alaska and Virginia. As the Chair of Music and a Professor at the University of Virginia in Charlottesville, I developed programs in ecoacoustics, interactive media, and Composition and Computer Technologies (CCT). In 2010, I founded the 501(c)3 environmental arts non-profit organization, EcoSono (http://www.ecosono.org), a group most active in Washington DC, Alaska and Colorado. In 2014, I traveled to Brazil to work with Al Gore, and now I work closely with his Climate Reality Group on environmental activism through music.

Below I will discuss the *Six Ecoacoustic Quintets No.1: Water (Ice)* (2010) for percussion quintet and interactive ecoacoustics. The piece is characteristic of how I combine live performance, technology, and natural systems to create my sound art. I discuss how the piece uses human/nature heuristics to create work of environmental activism.

Six Ecoacoustic Quintets (2010): Composing the human/environment feedback loop and some musical heuristics

The *Six Ecoacoustic Quintets* for percussion quintet, combines virtuosic percussion performance technique with natural materials and interactive acoustics. The percussionists play natural materials as musical instruments, and these sounds are amplified and processed by the computer. I start with a dynamic material relationship such as water/ice or sand/stone, and then design a methodology for navigating that transformation. In this way, the *instrument* encompasses both the material and its states of transformation. Performing this instrument is unlike a traditional instrument because it is far more variable. For this reason, the performer must learn to play these instruments in a different way, and the music needs to be notated in a different manner.

The performers interact with the natural material in a manner I describe as a human/nature dialect. This dialectical relationship is really a kind of feedback loop because as the human musicians manipulate the natural material the material simultaneously shapes what the musicians can play. The human energy and the environmental energy are in a mutual relationship. The concept of the music is thus embodied in the dynamic relationship between material and action. The music suggests that the *way* we relate to the natural world determines our being: as we affect and control our natural environment, the changes we enact in the world shape our behavior, psyche and imagination.

The quintet ensemble comprises a percussion quartet, and a fifth player who performs a more theatrical role than the others, elaborating the mystical and symbolic dimension of the music. The fifth player explores the music as a ritual, and sometimes

alters the sound production conditions of the other performers, for example by melting ice or removing the stones they are playing. Each *Quintet* is coupled with an optional *Ambient Extension* designed for performance by non-expert percussionists, perhaps even audience members. The *Ambient Extensions* allow a larger group to participate in the experience, and be complicit in the human/nature interaction.

My approach to environmental sound art employs music notation, and so the percussionists play from a score. The score describes how the performer relates to the material in more or less specificity. It is specific so that the music is repeatable without consultation of previous recordings or the composer, but it also creates an open space for discovery in order to create the feedback loop described above. By design the sonic result will vary depending on the interaction between the musician's imagination and the state of the material. The use of environmental materials as musical instruments poses interesting challenges for music composition. Musicians share no common practice for water as a musical instrument, yet everyone, musicians and non-musicians alike, has profound experience touching water and listening to the sounds it makes. People know how to manipulate these materials and even intone them in interesting ways, but the composer can't invoke notational conventions to explore them musically. This suggested an innovative approach to scoring music, and in the *Six EcoAcoustic Quintets* I use over 25 different musical notations, many newly invented.

Over its 45-minute duration, the piece progresses from the outward affects of human behavior (performers playing melting ice) to the human body as the material (performers playing their own skin). In this way, the overall form of the six pieces turns from the planet as material to the human as material. A concert listener will experience the following:

- In *Quintet No. 1: Water (Ice)* the performers play ice with heat, then play the water, and then segment the water into compartments and play those vessels.
- *Quintet No. 2: Wood (Pitch)* features the performers playing wooden percussion, sticks, leaves and branches. From the low log drum to the high wood block, the wooden percussion instruments get smaller. Lush, consonant harmonies emerge from the wooden rhythms and grow into the musical foreground. The harmonic beauty is *exchanged* for the wooden timbre and rhythmic vitality, like logging a forest in exchange for the energy to create light.
- In *Quintet No. 3: Stone (Sand)* the performers play stones, then sand, then sandpaper, then stones again. The cyclical form is confounded by loss of resources, because as the musicians try to accelerate and amplify the stone rhythm, the fifth player removes their instruments one by one. The percussionists try to increase sound production (amplified demand for energy), but fewer stones are available (reduced resources).
- The opening groove of *Quintet No. 4: Metal (Noise)* is disrupted by bursts of noise that cut the rhythm, undermining the flow of time. Meanwhile the clarity of the rhythm itself dissipates as the fifth performer gradually covers the instruments with tinfoil.

- *Quintet No. 5: Air (Breath)* features the performers vocalizing breath sounds and one player creating the beat with an electric fan prepared with a feather, a piece of paper and a stick.
- Finally, in *Quintet No. 6: Skin (Bone)* the percussionists play skin drums, bones and their own bodies. The music accelerates and crescendos into a climax that is both excitingly cathartic and tragically self-flagellating.

Let's look more closely at the first movement, *Quintet No. 1: Water (Ice)*. The performers gather around tubs of water with large chunks of ice suspended within (Fig. 23.1, left). Hydrophones frozen inside the ice and suspended in the water capture the sound underneath the water, and inside the ice (Fig. 23.1, right). Air microphones above the water capture the sound of the water close to the surface. In this way the technology allows us to hear across the material threshold in a way we cannot with our normal hearing. The listener hears the sounds of the air, underwater and inside the ice simultaneously, observing how the human energy ripples through various hydrologic states of gas, water and ice.

A closer look at the score illuminates how this action is scripted. Four percussionists play the water with their hands and the fifth player applies heat to the ice by pouring hot water onto the ice. The piece opens with a four-measure sequence (Fig. 23.2).

A unison quintuplet figure across a 5/4 measure leads to a free 5/4 measure of stirring and tapping the water, marked with a fermata. This is followed by a 3/4 measure of rest, also marked with a fermata, and the indication "wait for loud ice cracking sounds." The fifth player staff shows the intensity of the heat applied to the ice. In the first two

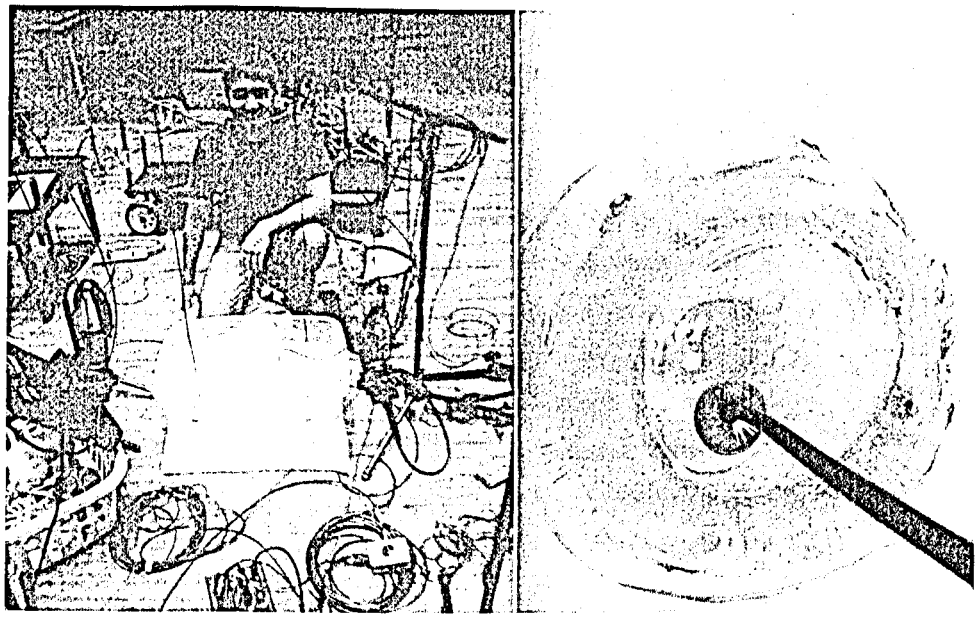


FIGURE 23.1 Tub of water/ice and heat applied to ice as musical system.

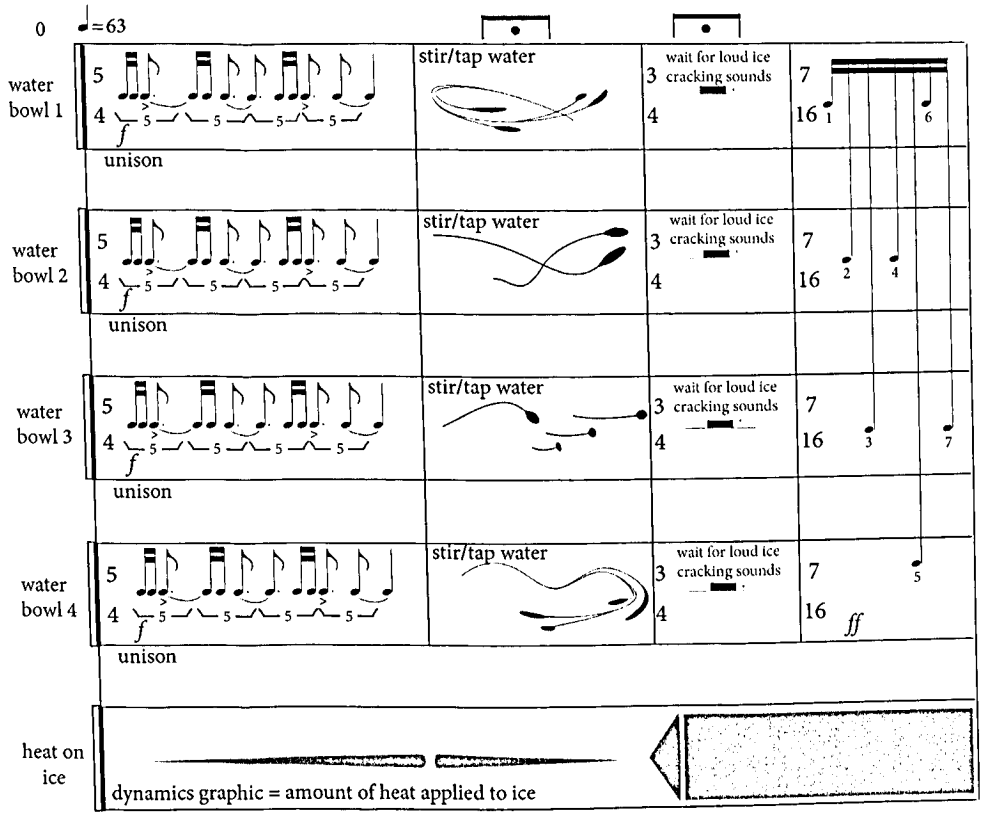


FIGURE 23.2 First four measures of *Six Ecoacoustic Quintets.*

measures the performer applies a very slight crescendo/decrescendo of heat that amplifies to full intensity leading into the third measure. The quick application of heat should cause internal cracking in the ice due to the rapid expansion of the molecules generated by the heat. When they hear the loud cracking the musicians move on to the 7/16 measure alternating on sixteenth notes.

These first measures reveal several approaches to scored human/nature interaction. Precise rhythmic music notation (m1) alternates with evocative graphic notation (m2), and the performers listen to the material for cues (m3) and listen to one another as an ensemble (m4). Meanwhile the fifth player applies some systemic force to the instrument, altering the conditions of the whole system. Each measure reveals a distinct way of interacting with the environment, a *heuristic* enabling a push and pull between the human imagination and environmental material. In the first measure the musician is asked to faithfully play the notated musical material, but the water splashes and ripples creating aleatoric microrhythms and imprecision that isn't written in the score. The sounding result does not quite match the notes in the music because of the behavior of the water. The measure suggests one desirable heuristic of the piece: human will is mediated by natural conditions.

The second measure gives a suggestive graphic notation. It encourages the musician to play *with* the water, not in spite of it. Here, the relationship between the water and performer is more consonant, but the invented graphical notation is less clear in some ways. For example, should the musician interpret the gesture going backwards in time when the graphic turns from right to left? And does the graphic show depth, or loudness, or articulation? The answers to these questions are found in the water, not in the score and so the musician must actually play the water to find out how to interpret the notation. The measure suggests another desirable heuristic: natural conditions contextualize and give performative form to human will.

The third measure tells the musician to "wait." Wait for sound. The score only provides a rest, a symbol of silence, but it says that the ice will create some sound as a result of the force of heat applied to the ice over time. The desirable heuristic here concerns listening to the world for cues, and letting systemic change trigger human movement. Human action is suspended in wait for some environmental change. Sometimes doing nothing is the most productive course of action, in music as well as in life.

In the fourth measure, the musicians respond in sequence, triggering one another. This measure is difficult to play because the performers must alternate precisely at a sixteenth note pulse, but as we know the water is also distorting the precision of their articulation. To play this measure, the human group must be acutely in balance with one another and with the water. The measure suggests that human-nature collaboration requires a deep sense of both human and environmental agents.

I look at the details of the first four measures in detail because the scope of the notated interaction found in these measures permeates the 169 pages of the whole piece. Each of these measures suggests a way of relating to the natural world, and these are expounded in different form throughout the score.

After exploring the surface of the water with their hands, the percussionists lower metal tubular bells into the water and build a harmonic polyphony above and below the surface of the water. They change the depth of the chimes to vary pitch, and strike the chimes at different speeds to create polyrhythmic pulsing. The polyrhythms transform into unison pulsing as shown below (Fig. 23.3).

The fifth player continues melting the ice according to the intensity staff. One by one the performers fill containers of water, which they shake like rattles. The ice presumably melted, the fifth player now performs the water using his/her hands. The original rhythmic figure is expanded into a canon, accompanied by the stirring water sounds (Fig. 23.4).

I feel this music is especially impactful when experienced as a performer. For this reason, I composed an accompanying score that can be performed simultaneously by any number of musicians or even by untrained audience members. Each of the *Six Ecoacoustic Quintets* has a companion score called an *Ambient Extension.* In the *Ambient Extensions,* notations from the quintet are extrapolated to maintain the experiential characteristic of the music but without the highly technical aspects. For example, here is one page from the *Ambient Extension No. 1: Water (Ice)* (Fig. 23.5).

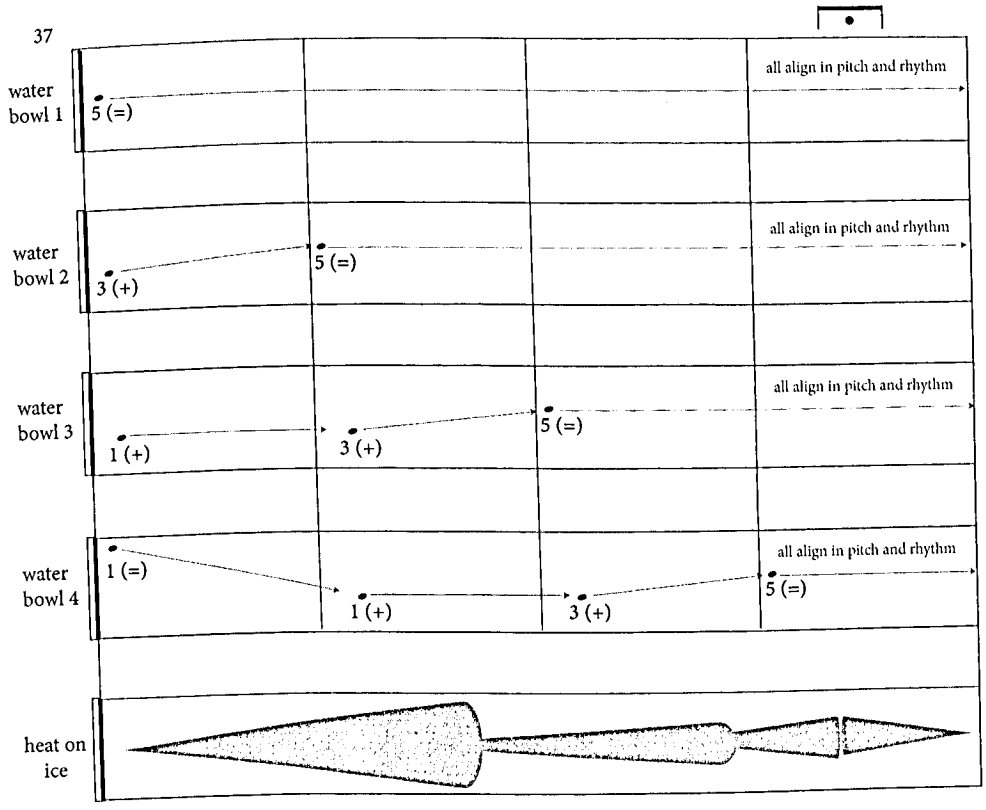


FIGURE 23.3 *Six Ecoacoustic Quintets No. 1: Water (Ice)* tubes in water and heat on ice notation.

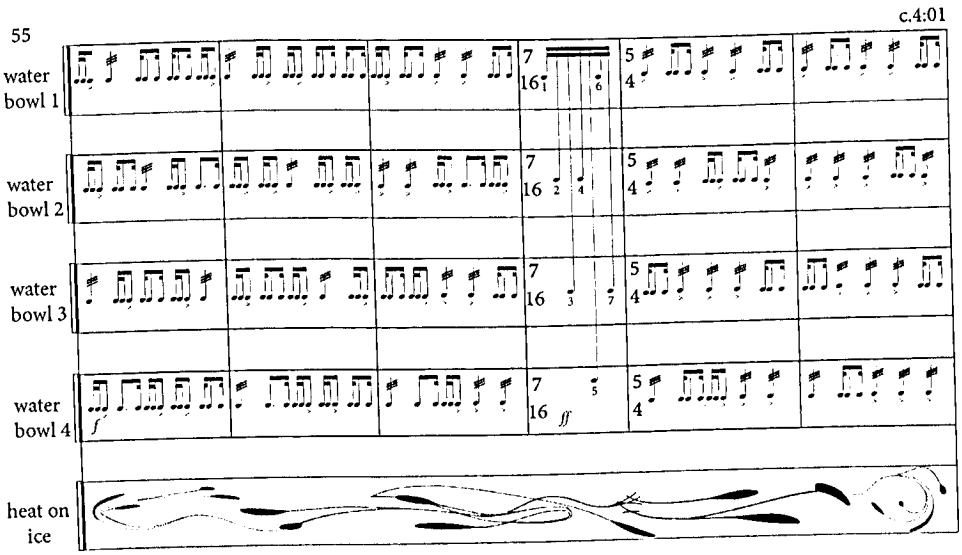


FIGURE 23.4 *Six Ecoacoustic Quintets No. 1: Water (Ice)* water shakers and stirring water notation.

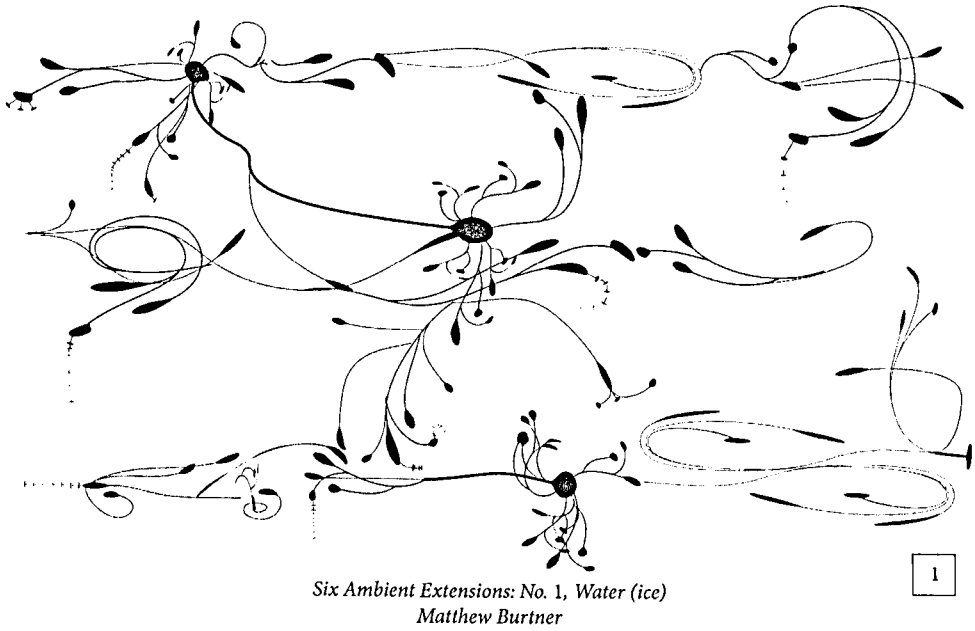


FIGURE 23.5 *Six EcoAcoustic Quintets, Ambient Extension No. 1: Water (Ice)* score excerpt.

Outcome

I discussed the details of a small part of the score in order to uncover a set of musical heuristics at work in the piece. These heuristics reveal an activism that will be abundantly clear to performers. But a non-performing listener has a different experience than a listener who is also performing the *Quintet* or *Ambient Extension.* The non-performing listener does not have ready access to the score, and therefore won't as easily identify the musical heuristics described above. Still, non-performing listeners understand the piece as a work of musical activism, and they comment on the use of natural materials as musical instruments, and on the extensive use of technology-mediated human/nature interaction.

In concert, the *Six Ecoacoustic Quintets* present the uncommon experience of classically trained musicians performing detailed rhythmic notations on materials such as sand or water. Further, these sounds are amplified in such a way that a listener can hear the nuances of the variability of the material. The sounds coming from each performer differ and they mix into an orchestration of surprising subtlety and richness. The performers give these natural materials the same care and attention as they would give a human-made instrument such as a violin or saxophone. But unlike human instruments, every person has experience touching earth or water, holding a stone, and noisily breathing air. And so even non-performing listeners can appreciate the fine attention to these materials as musical instruments. Listeners share this performance experience and can appreciate the musicianship and creativity of the performance. Hearing the natural material as a musical instrument is one striking aspect of the piece, and listeners often comment on this as a manifestation of environmentalism.

The performance stage is covered with tubs of water and ice, bowls of sand, piles of stones and branches, and interspersed with traditional percussion instruments. A typical performance of the piece also might use 24 microphones and so the stage presents a thick jungle of cables, microphone stands, and various mixing stations. Before the music even begins, an audience member will see that this performance features a fusion of human, environment and technology. Even the visible presence of electroacoustic technology helps communicate the concept of the work.

The piece has been performed in many contexts, from concert halls to outdoor spaces. Every time the materials are different and this gives great variety to the performances. The concert venues also vary. The piece was performed across distance technology, with performers located in several countries, and it has been performed outside on a lake with the audience wandering around the musicians as if in a garden of sound. The variability of the experience is one of the aspects I enjoy most about the music. The philosophy of the music is resilient in that it can be adapted for many contexts without losing the core message of the work.

Ecoacoustics offers a methodology for integrating experience and environment into an art practice. Philosopher Emily Brady has outlined a framework of *Integrated Aesthetics*, a model that applies well to ecoacoustics. We experience environmental conditions as immersive and changing, and Brady suggests *integration* as a way of describing this immersive experience. Integration she says "captures the environing experience of nature, as it surrounds the appreciator, as opposed to an experience of perceiving landscape from a distance, as a spectator would observe a painting." Brady's Integrated Aesthetic helps differentiate ecoacoustic approaches from more impressionistic environmental sounding art. Ecoacoustic techniques connect the musical systems directly to vital energy changes in the real world. Works such as *Six Ecoacoustic Quintets* may inspire an inquisitive listener to imagine their own movements in the world—on a beach, on gravel, in a lake, in the wind, or in the city—as a kind of musical performance. The expression of sound through material is deeply shared, and a listener understands the piece as a shared process of making music in the world.

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"*Environmental Sound Artists: In Their Own Words* is an extraordinary collection of self-descriptions of wonderfully alive and often iconoclastic work being done by ESAs today. Extremely well organized, edited, and exampled by Frederick Bianchi and V.J. Manzo, it will amaze, confound, entertain, and most importantly inform those with open minds on the present and future of art made in the free world. Unencumbered by strict labels of their work, these artists breathe air into oftentimes stagnant and commercial versions and views of art as described and prescribed by constraints arbitrarily defined centuries ago. I can't recommend it more enthusiastically."

—DAVID COPE

Featured Artists include . . . John Luther Adams, Ximena Alarcón, Leah Barclay, Joseph Bertolozzi, Philip Blackburn, China Blue, John Bullitt, Matthew Burtner, Craig Colorusso, Christopher DeLaurenti, David Dunn, Gordon Hempton, Bernie Krause, Cheryl E. Leonard, David Monacchi, Bruce Odland, Aki Pasoulas, Andrea Polli, Marty Quinn, David Rothenberg, Dawn Scarfe, Jeff Talman, Zimoun

ENVIRONMENTAL SOUND ARTISTS: IN THEIR OWN WORDS, is an incisive and imaginative look at the international environmental sound art movement. While the field of environmental sound art is diverse and includes a variety of approaches, the art form diverges from traditional contemporary music by the conscious and strategic integration of environmental impulses and natural processes.

This book presents a current perspective on the environmental sound art movement through a collection of writings by important environmental sound artists. Breaking through the limitations and gradual breakdown of contemporary compositional strategies, environmental sound artists have sought alternate venues, genres, technologies, and delivery methods for their creative expression. Environmental sound art is especially relevant because it addresses political, social, economic, scientific, and aesthetic issues. Awareness and concern for the environment has connected and unified artists across the globe and has achieved a solidarity and clarity of purpose that is singularly unique and optimistic. As this book illustrates, the environmental sound art movement is borderless and thriving.

FREDERICK BIANCHI is a composer and music technologist. Recognized internationally for his musical compositions, installations, and innovative music technology development, Bianchi has been associated with interactive music applications since the mid-1980s. His pioneering work in real time Virtual Orchestra development received a patent in 2004 and has been used in over two hundred thousand performances including collaborations with Lucent Technologies and Cirque du Soleil. Bianchi is currently Professor of Music at the Worcester Polytechnic Institute where he is Director of Computer Music Research.

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