

Fragments of Extinction: Acoustic Biodiversity of Primary Rainforest Ecosystems

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BACKGROUND

In 1998, while conducting a field recording campaign on Italian natural soundscapes, I had the intuition that the biophony [1] of untouched forest ecosystems should exhibit a more structured behavior, maximizing efficiency within diversity. I realized that, if properly reproduced, soundscape recordings of these ecosystems could be powerful means for raising awareness of acoustic biodiversity and its heritage [2], now being destroyed by rapid deforestation and climate change. When in 2002, with the help of Greenpeace, I traveled to the equatorial Amazon to record in an undisturbed area of old-growth rainforest, my hypothesis was immediately confirmed by finding extremely balanced acoustic systems produced by hundreds of species of insects, amphibians, birds and mammals neatly vocalizing within stunningly regular circadian cycles. Since then, I have been pursuing research and integration between the scientific inquiry of these soundscapes' configurations and the ways in which their aesthetic features can be explored, interplayed with and rendered for the public.

Aware that intensive field work was essential (Fig. 1), I traveled to the world's largest remaining areas of primary rainforest [3] along the equator (where, given the equal length between days and nights, life cycles—and thus sonic behaviors—are evolutionarily tuned to extremely regular patterns) and recorded 24-hour sound portraits of various habitats within what are considered to be the oldest and most diverse ecosystems on Earth. If we consider that the most recent International Union for Conservation of Nature (IUCN) [4] projections indicate that half of the original species (the great majority of them not even known to science) will be extinct by the end of this century, we also understand the urgency of recording sound examples of these diverse and unique, yet fragile, ecosystems: the remnants of nature's original "organized soundscapes."

FIELD RESEARCH

During my trips I have given great attention to the recording process. As compared to other scientific approaches, which mostly focus on a single species' sonic languages and behavior, the recording strategies I adopted called for a broader ecological perspective, involving the collection of as many components as possible of a complex soundscape. Within this approach, the spatial information of a given acoustic environment becomes a key element in understanding the complex-

ity of its organization and making it available to audiences. In high canopy forests, sounds come from every direction, including above (e.g. birds and monkeys) and below (e.g. amphibians and insects) the listening position. The human brain detects this three-dimensional (3D) information in its entirety through several subparameters that agree with our composite natural perception of direction, depth and dimension of sound sources. In order to record all these spatial attributes in the field, I employed "space-inclusive" and "space-preservative" standards and experimental mic techniques [5], enabling myself to fully reproduce these ecosystems over periphonic loudspeaker arrays. The investigation of long temporal sections (over 24 hours of continuous recording) in such remote and dangerous habitats forced me to develop recording strategies suitable to extreme conditions (humidity up to 99%, sudden rainstorms, absence of electric current) and self-sufficient systems for hazardous situations, capable of adjusting the sonic perspective to on-ground, mid-floor and canopy species. Taking into account all these concerns while making the most out of cutting-edge technology was a process of years of research, which resulted in vivid sound portraits of this endangered biological heritage, now available for posterity.

ABSTRACT

This paper describes the conceptual origins and development of the author's ongoing environmental sound-art project *Fragments of Extinction*, which explores the eco-acoustic complexity of the remaining intact equatorial forests. Crossing boundaries between bioacoustics, acoustic ecology, electroacoustic technology and music composition, the project aims to reveal the ordered structures of nature's sonic habitats, define a possible model of compositional integration and make the outcome accessible to audiences to foster awareness of the current "sixth mass extinction."

Fig. 1. The author recording Bai-Hokou saline, Dzanga-Sangha, 2008. (Photo © David Monacchi)



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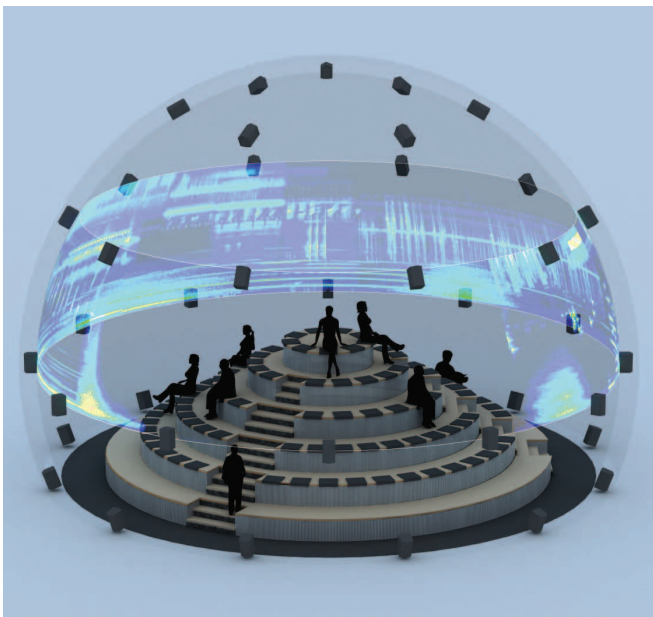


Fig. 2. The author's patented Bio-Acoustic Theatre, 12m diameter fixed version, 2013. (© David Monacchi)

INTEGRATING THE ORGANIZED SOUNDSCAPE

I used extensively detailed electroacoustic lab analyses with visual investigation tools to enter the framework of these soundscapes and to demonstrate their balanced organization, which is intuitively understood by a musician's ear. While intraspecific calls (individuals of the same species vocalizing from different territories) are traceable in recordings collected with space-preservative mic techniques, interspecific niche segregation dynamics only become evident through spectrogram analyses. Following a bio-acoustic "niche hypothesis" [1], my research primarily aims to reveal the aesthetic significance of typology/frequency/temporal sonic niches and their complex interactions within these untouched, therefore highly coordinated, natural systems.

Considering the possible artistic rendering of ecological processes, I was guided by two questions: Is it possible to learn from a primary ecosystem and to compose within the same laws that have shaped these ancient acoustic environments? Is it possible to deferently use compositional tools to reveal and enhance existing configurations of species? While exploring nature and trying to decode its sonic strategies, I developed a compositional approach to complement sound environments with performance, which I termed "eco-acoustic composition" [5]. One example—among others [6]—is the piece *Integrated Ecosystem* [7]. Here, a proportional and chronological time-lapse of a 9-hour continuous recording, followed by an exploration of the sonological properties of audible and

inaudible biophonies, is complemented by an electroacoustic performer's hand actions, with invisible sensors driving digital sound synthesis. The performer works strictly within available temporal and frequential acoustic niches left open by the other species' sonic "languages."

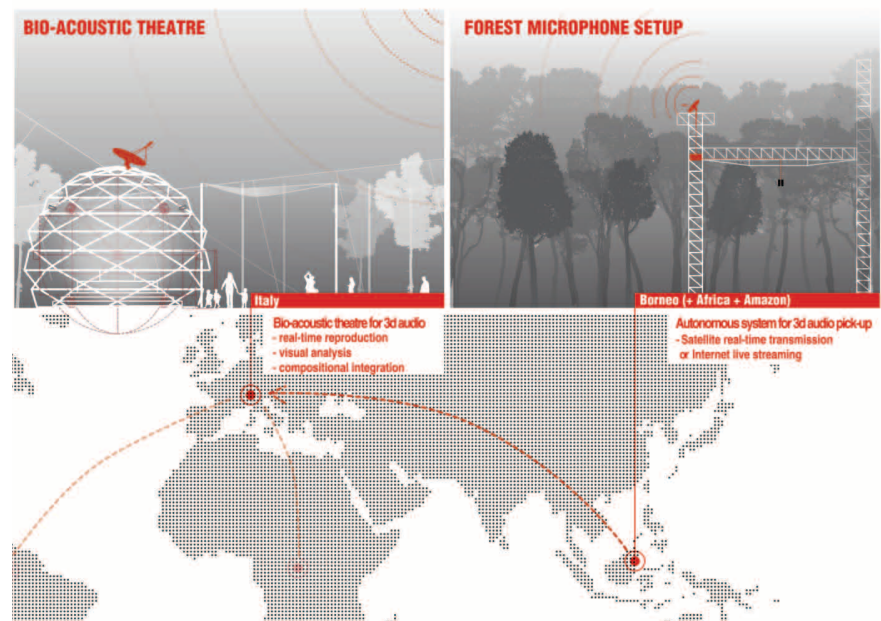
THE BIO-ACOUSTIC THEATRE

The aesthetic experience proposed by *Fragments of Extinction* [8] required a specific space to preserve the sonic characteristics (acoustic perspective and dimension of virtual sound sources) of these dense and diverse ecosystems. I en-

gineered the Bio-Acoustic Theatre (Fig. 2), an immersive facility [9] capable of reproducing periphonic 360° audio and visually rendering the real-time spectrogram of the soundscape as it unfolds. The theater, a scalable geodesic setup, consists of an array of 13 to 65 quasi-equally spaced loudspeakers, an array of projectors for circular display, and a seating system to optimize the placement of the audience toward the center of the venue for the best 3D sound illusion. Its shell is designed to maximize external noise reduction and internal sound energy absorption needed for sound intimacy and the periphonic sound reconstruction.

Inside the theater, the public is exposed to a sequence of three different sonic experiences in which the original soundscape undergoes increasing creative interventions: (1) *sound documentaries* (unaltered, continuous habitat recordings), (2) *transformations* (sonic time-lapses and electroacoustic explorations) and (3) *eco-acoustic compositions* (musical interactions with recorded/streamed ecosystems). A significant option, already implemented and suitable to all parts of the program, is live streaming from one of three chosen equatorial forests, realized through Internet or satellite transmission (Fig. 3). Although real-time feeds do not always express optimized soundscapes, the simultaneous immersion in an intimate habitat expressing its live dynamics arouses a different inclination to listening, and aims to make the audience aware that it

Fig. 3. Illustration of the real-time transmission to the Bio-Acoustic Theatre from three areas of primary rainforest where extensive field research was done (Amazon: Amazonas' Rio Juaoperi Xixuau, 2002; Congo Basin: Central African Republic's Dzanga-Sangha Dense Forest Reserve, 2008, 2010; Borneo: Brunei's Ulu Temburong Reserve, 2012, 2013). (© David Monacchi)



is witnessing an ancient, but disappearing, biome.

The theater program thus combines scientifically accurate soundscapes with musical integrations, proposing a progression of immersive, didactical and artistic experiences. The moving spectrogram analysis, projected on a giant screen and visible to the audience, is an analytical canvas on which the electro-acoustic performer observes the habitat's structure and its niches' configuration, and compatibly inserts ephemeral sensor-driven sound elements, building a powerful metaphor of the way music (our species' deepest sonic expression) can interplay within a composite live ecosystem, while trying to find a balanced relationship with it.

Acknowledgments

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References and Notes

1. Bernie Krause, *Into a Wild Sanctuary* (Berkeley, CA: Heyday, 1993).
2. R. Murray Schafer, *The Tuning of the World* (New York: Knopf, 1977).
3. For a thorough report, see David Monacchi, "Notes from Africa," Ear to the Earth Festival, New York (2009): <www.eartotheearth.org/articles/090502_notesfromafrica.html>.
4. "IUCN Red List of Threatened Species": <www.iucnredlist.org/about/red-list-overview>.
5. David Monacchi, "Recording and Representation in Eco-Acoustic Composition," in J. Rudi, ed., *Soundscape in the Arts* (Oslo: NOTAM, 2011) pp. 227–250.
6. David Monacchi, *Eco-Acoustic Compositions*, CD and booklet, EMF Media (2008).
7. The piece was the subject of analysis by Katharine Norman, "Listening Together, Making Place," *Organised Sound* 17, No. 3, 257–260 (2012).
8. Since 2003, the project has been adapted to a wide spectrum of situations and venues around the world, including contemporary music and sound-art festivals, science and natural history museums, contemporary art and environmental communication contexts. At present, the project also is being implemented for the World Expo 2015—Milan, which will provide one platform for the biodiversity crisis discourse, hopefully contributing to immediate inter-governmental tropical forest conservation policies.

9. Rossini S.P.A.C.E. (Soundscape Projection Ambisonic Control Engine), engineered by David Monacchi and Eugenio Giordani, is the first periphonic sound facility built in Italy. It operates as control room/mixing studio for the project.

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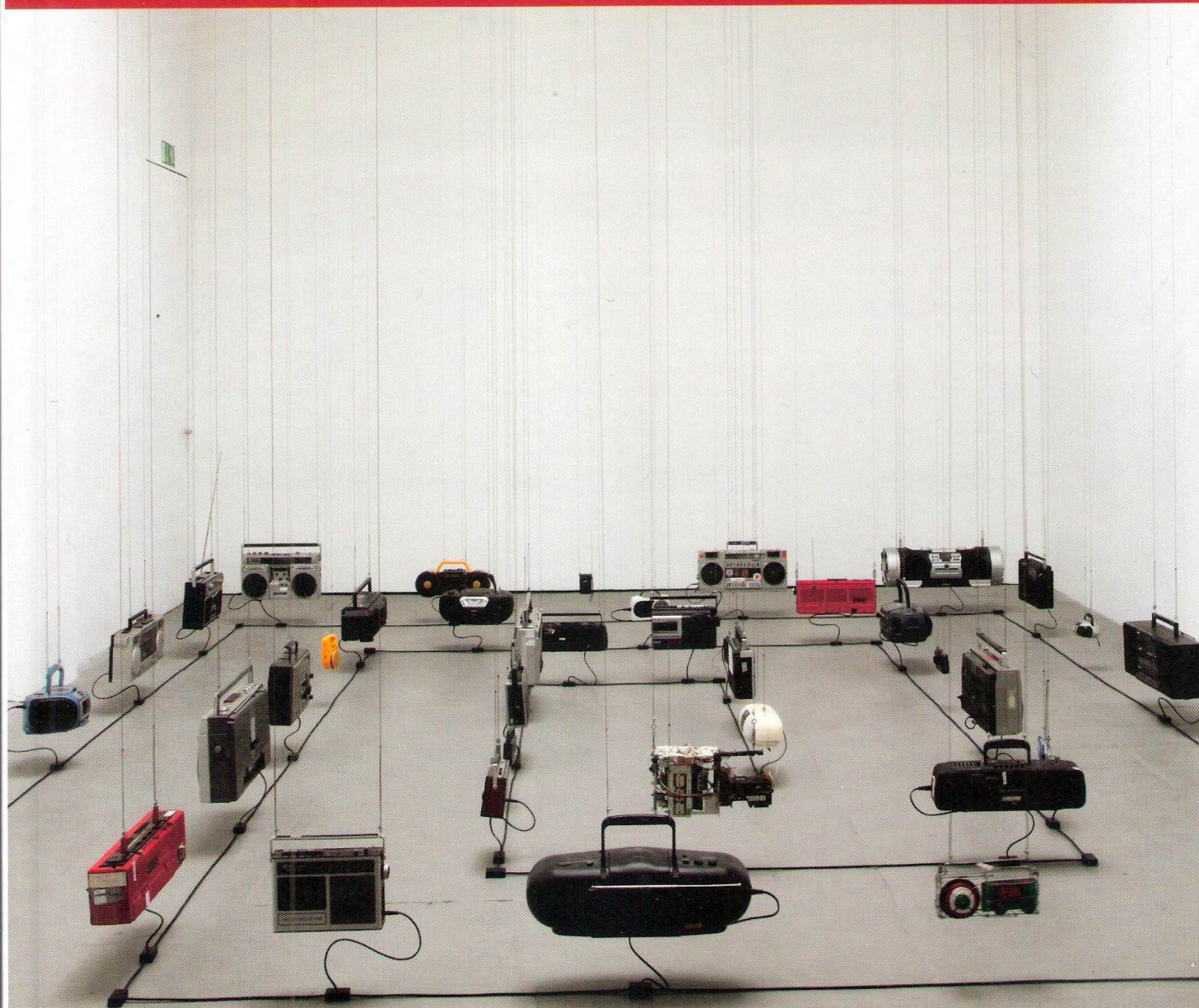
David Monacchi is a researcher, performer and eco-acoustic composer. He has been developing his multidisciplinary project Fragments of Extinction for nearly 15 years, conducting field research in the world's last remaining areas of primary equatorial rainforest. The recipient of multiple awards throughout Europe and North America, Monacchi is pioneering a new compositional approach based on 3D soundscape recordings of ecosystems to foster discourse on the biodiversity crisis through music and sound-art installations. A Fulbright fellow at UC Berkeley, he has taught at the University of Macerata and is now professor of Electroacoustic Music at the Conservatorio of Pesaro. He has released 65 CDs as a recording engineer, performer and composer, including: Prima Amazonia (Wild Sanctuary) and Eco-Acoustic Compositions (EMF Media).

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