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Ecoacoustics Congress

23-25 JUNE 2021

ON LINE

ABSTRACTS OF SCIENTIFIC PRESENTATIONS

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PROGRAM

WEDNESDAY 23 JUNE

				Time zone	
8.30-9.00	**Welcome**				
9.00-9.50	**Plenary talk 1**	Sueur	Jerome	0	Long-term ecoacoustics. a plea for slow science
9.50-10.10	O1	Hart	Patrick J.	+12	Acoustic niche partitioning in two tropical wet forest bird communities
10.10-10.30	O2	Linke	Simon	+10	Acoustic monitoring to evaluate environmental watering responses in the Koondrook-Perricoota Forest
10.30-10.50	O3	Roe	Paul	+8	The Design of the Australian Acoustic Observatory
10.50-11.20	Coffee Break				
11.20-11.40	O4	Brodie	Sheryn	+8	Using false-colour spectrograms for survey of long-duration acoustic recordings for ecological studies of frog chorusing
11.40-12.00	O5	Allen-Ankins	Slade	+8	Acoustic niche partitioning in frog assemblages
12.00-12.20	O6	Alcocer	Irene	0	Are acoustic indices effective proxies of biodiversity? A meta-analysis
12.20-12.40	O7	Bolgan	Marta	0	Passive Acoustic Monitoring of Fishes in the Mediterranean Sea. From single species to whole communities monitoring.
12.40-13.00	O8	Buscaino	Giuseppa	0	Spatio-temporal distribution and acoustic characterization of the haddock (*Melanogrammus aegglefinus, Gadiformes, Gadidae*) calls in the arctic fjord Kongsfjorden (Svalbard Island, Norway)
13.00-13.20	O9	Rocha Goncalves	Francisca	-1	#switchoffandlisten - acoustic ecology, ecoacoustics and listening practices towards inclusion with nature
13.20-15.00	**Lunch**				
15.00-15.20	O10	Comolet-Tirman	Jacques	0	Extreme vocalizations in songbirds . the case of the Mediterranean Flycatcher

15.20-15.40	O11	Haupert	Sylvain	0	How to determine the detection range of acoustic recorders in terrestrial environments?
15.40-16.00	O12	Vieira	Manuel	-1	Can we estimate marine biodiversity using sound recordings? Application of acoustic indices at Mozambique Island coral reefs. Poster
16.00-16.20	O13	Kohler	Christian	0	SIMON | eco acoustic – Scientific Monitoring Data Management and Online Repository for Eco Acoustics
16.20-16.50	Coffee Break				
16.50-17.10	O14	Sanchez-Giraldo	Camilo	-7	Soundscape and landscape relationship in the tropical Andes. Can acoustic complexity reflect the landscape ecological integrity?
17.10-17.30	O15	Almedia	Juan Ernesto	-8	Application of a sample space for the characterization of shaded coffee plantation soundscape
17.30-17.50	O16	Mullet	Timothy	-8	Walking in the Footsteps of Stuart Gage. My Transformation into Ecoacoustics
17.50-18.10	O17	Retamosa Izaguirre	Monica	-8	Acoustic indices applied to biodiversity monitoring in a tropical rainforest of Costa Rica
18.10-18.30	O18	Sanchez	Natalie V.	-8	Does vegetation structure shape the acoustic features of Lincoln's Sparrow songs?
18.30-18.50	O19	Hellier	Ruth	-9	Eco-acoustic-arts. teaching qualitative ecoacoustics through sonic arts, birds & environmental sensitivities
18.50-19.10	O20	Buzzetti	Filippo Maria	0	Zeuneriana marmorata and Uromenus annae (*Insecta. Orthoptera*). Songs from the verge of extinction

THURSDAY 24 JUNE

				Time zone	
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9.20-9.40	O21	De Rosa	Alberto	+10	Miniature recorders embedded in radio transmitters help to elucidate behaviours and inform monitoring practices in a New Zealand endemic flightless bird
9.40.10.00	O22	Juodakis	Julius	+10	Sound event detection in long-term recordings using changepoints
10.00-10.20	O23	Moran	Ines G.	+10	Individual recognition in rifleman, *Acanthisitta chloris*: Machine learning classification helps identify individual bird calls from audio recordings
10.20-10.40	O24	Fuller	Susan	+8	Diversity favours the old: Metrics of avian diversity increase in aging regrowth Acacia woodlands of semi-arid eastern Australia.
10.40-11.10	Coffee Break				
11.10-11.30	O25	Chae	Soyeon	+7	The soundscape patterns of urban spaces with varying degrees of connectivity in metropolitan Seoul
11.30-11.50	O26	Mazzoni	Valerio	0	Biotremology as a new tool of ecoacoustics
11.50-12.10	O27	Monacchi	David	0	Sonosphere – An ecoacoustic theatre for science-based listening experiences
12.10-12.30	O28	Mueller	Sandra	0	Polycultures show higher acoustic diversity than monocultures in a Panamanian tree diversity experiment
12.30-12.50	O29	Portaccio	Alessia	0	Assessing the presence and species richness of owls and woodpeckers through bioacoustics in two differently managed Alpine forests
12.50-13.10	O30	Picciulin	Marta	0	Does noise matter ? Passive Acoustic Monitoring reveals the co-occurring presence of two threatened sympatric vocal species (*Sciaena umbra* and *Umbrina cirrosa*; Sciaenidae) in highly anthropized Venice inlets

13:10-14:10	**Workshop**	Wildlife Acoustics			Using Wildlife Pro to Analyse Bird and Other sounds
14.10-14.30	O31	Riede	Klaus	0	Data-mining soundscapes for Orthoptera monitoring: challenges and opportunities
14.30-14.50	O32	Shaw	Taylor	0	Hybrid bioacoustic and ecoacoustic analyses provide new links between bird assemblages and habitat quality in a winter boreal forest
14.50-15.10	O33	Tietze	Thomas	0	Trade-off between song complexity and colorfulness in parid birds
15.10-15.30	O34	Wallis	David	0	The application of direction of arrival methods for animal localisation
15.30-16.20	Plenary talk 3	Krause	Bernie	-9	The future belongs to those who can hear it coming (a paraphrase of a David Bowie aphorism)
16.20-16.50	Coffee Break				
16.50-17.10	O35	Arias Aguilar	Adriana Patricia	-5	Songs of a fishing bat: echolocation call variation of the greater bulldog bat across the Neotropics
17.10-17.30	O36	da Costa	Cintia Fernanda	-5	Bats of the neglected Brazilian-Uruguayan savanna: occupancy, diversity and conservation
17.30-17.50	O37	Cahalan	Gabriel	-6	Acoustic measures of bird communities in a thinned and burned coastal plain pine forest
17.50-18.10	O38	McCordic	Jessica A	-6	Monitoring vessel use and characterizing acoustic species assemblages in the soundscapes of two Australian marine parks
18.10-18.30	O39	Doser	Jeffrey	-6	Assessing soundscape disturbance through hierarchical models and acoustic indices: a case study on a shelterwood logged northern Michigan forest
18.30-18.50	O40	Munoz Duque	Sebastian Eduardi	-7	Passive acoustic monitoring for identification and location of a migratory fish spawning areas in a tropical Andean river
18.50-19..10	O41	Supervie	Armelle	0	Musical use of nature sounds - Perspectives from the second part of the 20th century
19.10-19.30	O42	Sugai	LSM	0	The rise and fall of Biophony and the drivers of the acoustic space

FRIDAY 25 JUNE

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9.20-9.40	O43	Girola	Elisa	+8	Singing in a noisy ocean: can male humpback whales cope with natural and anthropogenic noise?
9.40.10.00	O44	Scarpelli	Marina D.A.	+8	Developing a fine-scale soundscape spatial model for measuring biodiversity in a semi-arid landscape
10.00-10.20	O45	Scarpelli	Marina D.A.	+10	What does Atlantic Forest soundscapes can tell us about landscape?
10.20-10.30	O46	Listanti	Virginia	+10	What can Mathematics teach us about spectrogram?
10.30-11.00	Coffee Break				
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11.20-11.40	O48	Gamba	Marco	0	The acoustic diversity and complexity of the Maromizaha Forest Reserve, Madagascar
11.40-12.00	O49	da Silva Cerqueira	Aline	-1	At-sea acoustic tracking of seabirds: exploring the soundscapes of highly mobile predators during foraging
12.00-12.10	O50	Obaid	Sara	1	Acoustic monitoring of wetland habitats in dry regions (Kuwait): bird community dynamics related to migration
12.10-12.30	O51	Nieri	Rachele	0	Semiochemicals, semiophysicals and their integration for the development of innovative multi-modal systems for agricultural pests' monitoring and control
12.30-12.50	O52	Borkar	Shashank	+3	Elucidating the acoustic dynamics of Indirana chiravasi with special emphasis on temperature and humidity
12.50-13.10	O53	Lamount	Andrea	0	Preserving the sounds of the earth and supporting scientific projects through sonic, music and digital experiences

13.10-13.30	O54	Rok	Sturm	0	Ecotremology - new insights into hidden ecosystems: a pioneer study in meadow habitats
13.30-15.00	Lunch				
15.00-15.20	O55	Greenhalgh	Jack	-1	Ecoacoustics as a novel tool for assessing pond restoration success: Results of a pilot study
15.20-15.40	O56	Minghim	Rosane	-1	Visualization and data science advances in soundscape ecology
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15.50-16.10	O58	Ferri	Vincenzo	0	Bats on Waterways inside a City: Bioacustic Research in Brescia (Lombardy, Italy)
16.10-16.30	O59	Llusia	Diego	0	Listening to climate change: a framework to forecast species spatial and phenological shifts using acoustic monitoring
16.30-16.40	Coffee Break				
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17.10-17.30	O62	Retamosa Izaguirre	Monica	-8	Soundscape and bird community at the Braulio Carrillo National Park, Cost Rica, related to highway 32
17.30-17.40	O63	Manzano	Maria Carolina	0	Tuning acoustic communities: phylogenetic, functional and acoustic beta diversity
17.40-18.00	O64	Grinfeder	Elie	0	What is soundscape?: New perspectives based on functional representation
18.00-18.10	O65	Jaswal	Akash	+3	An ecoacoustic study of urban forest landscape of National Capital Region of Delhi
18.10-18.20	O66	Ducrettet	Manon	0	Tropical acoustic diversity: monitoring of a seed disperser, the White throated toucan
18.20-18.40	O67	Metcalf	Oliver	+1	Acoustic indices perform better when applied at ecologically meaningful time and frequency scales
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	Poster				

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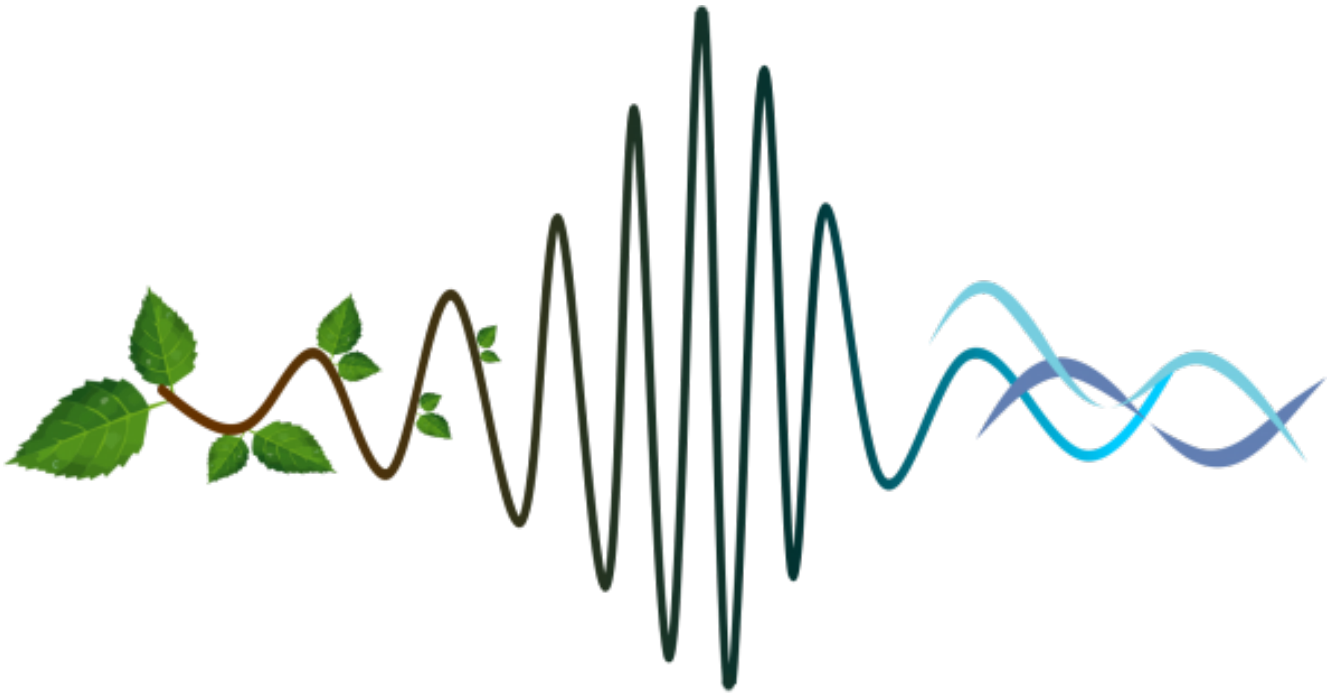

PLENARY 1 - Wednesday 23

Long-term ecoacoustics: a plea for slow science

Jérôme Sueur, Institut de Systématique, Évolution, Biodiversité (ISYEB), Muséum national d'Histoire naturelle, CNRS, Sorbonne Université, EPHE, 57 rue Cuvier, 75005 Paris, France

Climate change is a fast event at the scale of geological times but a slow phenomenon at the scale of a researcher career. Assessing the impacts of climate change on natural systems requires an extensive amount of time over years to collect meaningful ecological data. Long-term remote monitoring is one mainstay of ecoacoustics. However, running ecoacoustic research programs over years is a challenge in terms of human resources, financial support, equipment maintenance, data saving, and results analysis. Here, I will introduce two long-term programs that we started at the same time in a cold forest in France mainland (Jura) and in a tropical forest in France overseas (Guyane). I will describe the local ecological context, the research framework, the field sampling protocol, data management, some preliminary results and future analysis. This will be the occasion of a plea for slow, relaxed, and aesthetical ecoacoustics.

PLENARY 2 - Thursday 24

N-Eared Listening: Transdisciplinary Ecoacoustics at human-environment interfaces

Alice Eldridge, Sussex Humanities Lab & Sussex Sustainability Research Programme, University of Sussex, Falmer, Brighton. UK

Understanding, managing and improving human-environment interactions is amongst the most pressing challenges of our time. However, this is a wicked problem that we need to approach from multiple perspectives. I will outline a series of case-studies in inter- and transdisciplinary soundscape research: from validating ecoacoustic metrics in temperate UK woodlands, through wilderness mapping in the Swedish Arctic and community-led reef restoration in Indonesia to indigenous-led cultural heritage projects in the Ecuadorian Amazon. In doing so I aim to illustrate the value of integrating different forms of knowledge across disciplines, everyday and indigenous practices and speculate that triangulating ecological theory and computational methods with human experience might point to valuable new approaches to ecoaoustic analysis and even inspire fresh consideration of core conservation imperatives, in order to better align the anthroposphere and biosphere for the benefit of all.

PLENARY 3 - Thursday 24

The Future Belongs to Those Who Can Hear It Coming (a paraphrase of a David Bowie aphorism.)

Bernie Krause, Wild Sanctuary - PO Box 536, Glen Ellen, CA

Since I first engaged with the ecology of sound fifty-three years ago, the density and diversity of wildlife acoustic signatures has diminished markedly. At some sites, as a direct consequence of anthropogenic climate change and other exploitive human endeavor, the biophony can no longer be heard in any form. This essay of personal thoughts on my evolution to ecoacoustics is framed by the title, a paraphrase of the late David Bowie aphorism. Bowie's deeply profound observation speaks to a host of insights that flow from it. Most important, we can no longer disregard the cries of wild organisms and human ensembles living closely connected to the natural world, those begging for relief from the relentless corporate assault on the earth's finite resources that have otherwise sustained them from the beginning. It is an onslaught now transmitted all too eloquently through the otherwise life-affirming voices of the natural world, its biophonies and geophonies, as these critters struggle for purchase. Will this descent toward silence be the world-wide outcome of Bowie's prediction? What can be done to alter this course? And who among us will take the lead?

PLENARY 4 - Friday 25

Connecting bioacoustics to ecoacoustics to ecology. A new challenge for environmental monitoring and conservation through acoustics.

Gianni Pavan, Centro Interdisciplinare di Bioacustica e Ricerche Ambientali, Dipartimento di Scienze della Terra e dell'Ambiente, Università degli Studi di Pavia - Via Taramelli 24, 27100 Pavia, Italy - Email gianni.pavan@unipv.it

Besides his anthropocentric view, Schafer was a pioneer in highlighting the need for soundscape research and management. In his book, *The New Soundscape*, Schafer (1969) documents rapid changes in soundscapes with the course of human civilization. However, Rachel Carson, in her book *Silent Spring* (1962), was the first to recognize the biophony as the natural expression of an ecosystem and to forecast its degradation in response to human impacts. She expressed her concern for the massive use of chemicals and pesticides in agriculture and their impact on fauna and soil microfauna. She foresaw a silent world without the beautiful songs of birds, frogs, and insects killed by chemicals produced by industries and used in intensive agriculture, or these vocal animals disappearing because of dramatic habitat transformation imposed by industrial and urban development.

Following the development of Bioacoustics and Acoustic Ecology, now consolidated in the emerging field of Ecoacoustics, natural and anthropogenic sounds are recognized as ecological indicators and as essential drivers of several ecological processes in terrestrial and aquatic ecosystems. Now we consider the *soundscape*, in its strict description, as the result of human perception, and the *acoustic environment*, that exceeds the human hearing limits, extending into the realm of vibrations, infrasounds, and ultrasounds, even in water and below the threshold level of human perception. However, the term soundscape is often used in its broadest significance, largely exceeding human hearing and interpretation.

This discipline still requires continuous development, in theory, models, and methods, to connect Bioacoustics to Ecoacoustics and Ecology for environment management by providing robust ecological indicators in both the short and long time, in small areas as well as in wide ecological regions.

The use of ecoacoustic indicators, or indices, is still in its infancy. The emerging computational bioacoustics/ecoacoustics is slowly providing new tools to recognize specific sounds (species identification) and to generate global indices to robustly describe ecosystem by identifying sonotopes and acoustic communities.

However, a widely accepted protocol for data acquisition and processing is still undefined, as well as it is not clear how to connect some indices to ecosystem structures and processes.

All these advances support the development of the soundscape conservation issue and the study of the noise pollution effects on the health of ecosystems and of human beings.

The acoustic quality of the environment in wild and remote ecosystems, and in human-impacted areas, represents a value to be preserved and improved for the well-being of animals and humans. To conclude, we need to establish largely accepted and robust protocols to describe the evolution of sonosystems locally and globally to support nature conservation.

COMMUMICATIONS AND POSTERS

Wednesday 23

O1- Acoustic niche partitioning in two tropical wet forest bird communities

Hart, P.J., Department of Biology, University of Hawaii at Hilo, USA
Ibanez, T. Department of Biology, University of Hawaii at Hilo, USA
Paxton, K.,Department of Biology, University of Hawaii at Hilo, USA
Tredinnick, G.,Department of Biology, University of Hawaii at Hilo, USA
Sebastián-González, E., Departamento de Biologia Aplicada, Universidad Miguel Hernández, Elche, Spain
Tanimoto-Johnson, A. Department of Biology, University of Hawaii at Hilo, USA

When acoustic signals sent from individuals overlap in frequency and time, acoustic interference and signal masking may occur. Under the acoustic niche hypothesis (ANH), signaling behavior has evolved to minimize overlap with heterospecific calling individuals through selection on signal structure and the sender's ability to adjust the timing of signals. In this study, we examine the fine-scale use of acoustic space and the relevance of the acoustic niche hypothesis in two montane tropical wet forest bird communities (Costa Rica and Hawaii) that vary in bird species richness but have similar overall bird abundance. We used a null model approach to test the prediction that there are differences between observed and expected signal overlap in both communities and also that acoustic niche partitioning is greater in the species-rich community (Costa Rica) due to greater selection to reduce inter-specific signal overlap. As predicted under ANH, we found much lower overlap of acoustic signals in both bird communities than expected by chance. In addition, spectral and temporal overlap between different signals was very rare within one-second sound-slices examined for Costa Rica but occurred within approximately 37 % of those examined for Hawaii. These findings constitute the strong support to that there is competition for acoustic space in signaling communities, and this has resulted in temporal and spectral partitioning of the soundscape.

O2- Acoustic monitoring to evaluate environmental watering responses in the Koondrook-Perricoota Forest

Simon Linke [1] , Daniella Teixeira [1] , Katie Turlington [1] , Sarah Treby [2] , Jean Dind [2] , Jo-Anne Deretic [3], Paul Roe [4]
[1]Griffith University, Nathan, QLD, Australia
[2]Forestry Corporation of NSW, Deniliquin
[3]Goulburn-Broken CMA, Shepparton
[4]QUT, Brisbane

This project successfully developed, tested and implemented call recognisers for eight species of frog in the Murray-Darling Basin. Recognisers for all but one species performed well and substantially better than many species recognisers reported in the literature .We achieved this through a comprehensive development phase, which carefully considered and refined the representativeness of training data, as well as the construction (amplitude cut-off) and the similarity thresholds (score cut-offs) of each call template used. We demonstrated the utility of automated frog call detection to monitor ecosystem response at all watered sites. At most sites the response was almost instant – calls were close to a peak around one week after watering. The sharp response curves by the recognisers demonstrate the utility of multi-species call recognisers. This is demonstrated in the diagram below – as soon as water reaches a site, frog calls increase significantly. We tested this using a Linear Mixed Model, in which we contrasted watered and control sites – showing that only watered sites increase in activity. While slightly more involved than building recognisers using commercial packages, the workflows ensure that a high quality recogniser can be built for which the performance can be fine-tuned using multiple parameters. Using the same framework, recognisers can be fine-tuned in future iterations. We believe that multi-species recognisers are a highly effective and precise way to detect the effects of ecosystem restoration – in this case environmental watering - delivering a much sharper response signal than previous index based analyses.

O3- The Design of the Australian Acoustic Observatory

Paul Roe, QUT
Richard Fuller, University of Queensland
Paul McDonald, University of New England
Lin Schwarzkopf, James Cook University
David Tucker, QUT
Anthony Truskinger, QUT
David Watson, Charles Sturt University

The Australian Acoustic Observatory is a unique piece of infrastructure which will ultimately collect ecoacoustic data from 400 sensors around Australia. It is the first long term terrestrial acoustic observatory, and the only continental-scale acoustic array. Deployments have started and data is being collected. Sound data is continuously recorded and all data are being made freely available; the resulting dataset will be the largest ecoacoustic data set ever collected, 400 sensors by a five year initial project lifetime resulting in two millennia, two Petabytes, of sound. Unlike bioacoustics and single species studies, the research questions driving the observatory and associated data collection are broad-based and open-ended: to monitor biodiversity, phenology and species distribution, and to catalyse ecoacoustics research. The acoustic dataset represents a baseline data collection: the overall spatial temporal distribution of species is simply unknown. Given the general research questions and continental deployment there are many possible design options for such a unique infrastructure. This talk will outline the issues and challenges faced with designing an acoustic observatory and the reasons for the particular design decisions taken, including hardware, software, protocols, sensor location and people.

O4- Using false-colour spectrograms for survey of long-duration acoustic recordings for ecological studies of frog chorusing

Sheryn Brodie[1*], Michael Towsey[2], Slade Allen-Ankins[1], Paul Roe[2], Lin Schwarzkopf[1].
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[2] QUT Ecoacoustics Research Group, Science and Engineering Faculty, Queensland University of Technology, Brisbane Qld Australia.
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Continuous recording of environmental sounds could allow long-term monitoring of vocal wildlife, and scaling of ecological studies to large temporal and spatial scales. However, such opportunities are currently limited by constraints in the analysis of large acoustic data sets. Computational methods and automation of call detection require specialist expertise and are time consuming to develop, therefore most biological researchers continue to use manual listening and inspection of spectrograms to analyse their sound recordings. False-colour spectrograms were recently developed as a tool to allow visualisation of long-duration sound recordings, intending to aid ecologists in navigating their audio data, and detecting species of interest. This paper explores the efficacy of using this visualisation method to identify multiple frog species in a large set of continuous sound recordings and gather data on the chorusing activity of the frog community. We found that, after a learning process, frog choruses could be visually identified to species with high accuracy. We present a simple R routine to interactively select short segments on the false-colour spectrogram for rapid manual checking of visually identified sounds. We contend these methods could be applied to analyse calling patterns in other chorusing species.

O5- Acoustic niche partitioning in frog assemblages

Allen-Ankins, S., College of Science & Engineering, James Cook University, Townsville, Australia.
Schwarzkopf, L., College of Science & Engineering, James Cook University, Townsville, Australia.

Acoustic signaling is an important communication method for many animal species. Given this, species usually occur in environments surrounded by many interspecific signals. These signals may interfere acoustically with one another, impeding the detection and localisation of conspecific signals. To avoid these costs, it has been suggested that animals should partition the acoustic niche to reduce acoustic competition. The aim of this study was to determine whether frog assemblages display evidence of acoustic niche partitioning. We used a null model approach to compare observed and expected levels of interspecific acoustic similarity in frog assemblages recorded across Australia over a one year period. We examined species 95% call frequency bandwidths, dominant call frequencies, and a combination of spectral and temporal call features. If frog assemblages are randomly assembled with regard to the spectral properties of their calls, then we would expect there to be no difference in acoustic similarity between observed assemblages and random assemblages. However, if they are partitioning the acoustic space, then we expect lower acoustic similarity between species calls in observed assemblages when compared to random assemblages. We found that most assemblages had lower acoustic similarity than random assemblages. Specifically, their 95% call frequency bandwidths overlapped less than expected, there was greater distance between their dominant call frequencies than expected, and there was greater distance between their calls when considering multiple call features than expected. These results are consistent with the acoustic niche hypothesis, suggesting that frogs partition the acoustic space to reduce competition.

O6- Are acoustic indices effective proxies of biodiversity? A meta-analysis

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Lima, H., Global Change Ecology and Evolution group, Department of Life Sciences, University of Alcalá, Alcalá de Henares, Spain
Sugai, L.S.M., Terrestrial Ecology Group, Science Faculty, Universidad Autónoma de Madrid, Madrid, Spain
Llusia, D., Terrestrial Ecology Group, Science Faculty, Universidad Autónoma de Madrid, Madrid, Spain

As biodiversity decreases worldwide, the development of efficient tools to detect environmental changes becomes an urgent challenge for scientists. In this regard, the use of animal sounds has been suggested to be an important source to understand biodiversity along with its spatial and temporal changes. To extract biodiversity patterns from a massive quantity of passive acoustic recordings, acoustic indices emerged as a promising tool to characterize populations and communities. Since the development of the first acoustic indices, the efficiency of acoustic indices as a proxy of biodiversity have been explored for multiple taxa and ecosystems. However, we still lack a general synthesis that answers i) are acoustic indices good indicators of biodiversity, and if so ii) which acoustic indices perform better, iii) and in what circumstances. To shed light on these questions we collected data available in the literature and conducted a meta-analysis to evaluate how acoustic indices perform in estimating biological diversity. We found that acoustic indices exhibit a moderate but positive correlation with biodiversity. Sub-group analysis using the 7 alpha acoustic indices present on our dataset, revealed marked differences in their correlation with biodiversity. In addition, we explored the correlation variability across environments and different biodiversity metrics. Our findings highlight the limits and potential of synthesizing species diversity from environmental sound recordings and promote a debate on the generalization of acoustic diversity as a biological component.

O7- Passive Acoustic Monitoring of Fishes in the Mediterranean Sea: from single species to whole communities monitoring

Marta Bolgan[1], Marta Picciulin[2], Lucia di Iorio[3] and Eric Parmentier[1]

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[2] Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari; University of Venice, Venice, Italy

[3] CHORUS Institute, 115 rue des Alliés, Grenoble, France.

In the Mediterranean Sea, Passive Acoustic Monitoring of fish populations has been carried out since 2002; studies have focused on single species monitoring (mainly *Sciaena umbra* and *Ophidion rochei*), as well as on the monitoring of whole fish communities in a wide range of coastal environments. These studies have proved that the same species can be monitored over wide geographical and temporal scales thanks to the consistency of its acoustic signature, which can also be used to identify cryptic species which would otherwise go undetected. Recently, the monitoring of whole vocal fish communities has provided high resolution information on fish taxonomic richness and diversity. Furthermore, the allocation of acoustic resources within the community signal space and fish realised acoustic niches were found to change in relation with acoustic diversity and sonic-system morphology, introducing the concept of Acoustic Niche plasticity in acoustic fish communities. Recent investigations have started to shed lights on the possibility of extending the monitoring of vocal fish populations at depth greater than those usually considered. In this presentation, past and present studies are discussed at the light of future perspectives and recommendations for fostering the monitoring of vocal fish populations in our rapidly changing seas.

O8 -Spatio-temporal distribution and acoustic characterization of the haddock (*Melanogrammus aeglefinus*, Gadiformes, Gadidae) calls in the arctic fjord Kongsfjorden (Svalbard Islands, Norway)

Buscaino G[1]*, Picciulin M[2], Canale DE[1], Papale E[1], Ceraulo M[1], Grammauta R[1], Mazzola S[1].

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In this study we analyzed the acoustic properties and the presence of haddock calls in the Arctic fjord Kongsfjorden (79° N – 12° E, Svalbard Islands, Norway) during one year. Data were collected with three autonomous acoustic recorders located in the inner, middle, and outer part of the fjord. The fjord is characterized by a gradient in the oceanographic conditions, from the inner to the outer parts of the fjord, reflecting changes from Arctic to Atlantic waters. Haddock sounds were more abundant in the outer compared to the middle fjord, whereas they were absent in the inner site. They were recorded from July to October, that is out of the spawning period. The call abundance revealed a strong periodicity and correlation with the cycles of neap tide (15 day) and tide (12 hour) in July and August, with a clear diel cycle (24 hour) in September and October. This result suggests that in this extreme enviroment, with 24 hour of light during summer, haddocks regulate their acoustic activity over the main available oscillating physical external driver, such as the tide during the polar summer; while, when the alternation light/dark starts, they shift the periodicity of their call to a diel cycle.

O9- #switchoffandlisten - acoustic ecology, ecoacoustics and listening practices towards inclusion with nature

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Acoustic ecology and ecoacoustics can be powerful tools to develop artistic approaches towards nature-connectedness. The psychological model for human inclusion with nature argues that individuals' connection with nature will dictate their behaviours towards protecting it. In this sense, emotion is crucial when understanding environmental attitudes and behaviours. Moreover, an emotional affinity defined by the individual's bond with nature is considered the basis for developing pro-environmental actions and commitments. The more time a person spends in nature, the more intimate their relationship becomes. This paper details artistic strategies for creating an underwater noise awareness campaign #switchoffandlisten. It explores listening strategies as tools to tune into a place. The goal is to reinforce emotional affinity and connectedness to nature through underwater listening workshops. We took the audience on boat tours for underwater listening while doing ocean soundscape recordings. By listening to ocean soundscapes with and without anthropogenic influence, the audience could feel the problem of noise pollution in a more grasping way while connecting emotionally to the underwater environment and their species. The outcome was a collaborative performance.

O10- Extreme vocalizations in songbirds : the case of the Mediterranean *Flycatcher Muscicapa tyrrhenica*

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Several kinds of vocalizations have been described in songbirds, including the following:

- Territorial songs, meant to carry as far as possible (→ soundscapes)
- Alarm calls, also meant to carry some distance, with a supra-specific message
- Vocalizations with a more intimate purpose (→ sonotope) such as subsongs and nuptial songs

Territorial songs tend to be louder and often play a major role in soundscapes, whereas subsongs may be heard at close range only.

Most songbirds vocalizations remain well below 10 kHz. Among songbirds reaching high frequencies (for instance above 7 kHz), a classification test can be proposed, introducing the categories above further divided according to the regularity with which high frequency sounds are emitted, for instance (territorial songs):

- Songs remarkable for their narrow frequency range such as *Dendroica striata* in North America or *Regulus ignicapillus* in Europe (note that both remain under 10 kHz).
- Songs covering a wide frequency range and occasionally reaching high notes (13 kHz : *Molothrus ater* in North America).

Using these categories, we will discuss the song of the Spotted Flycatcher *Muscicapa striata* and the song of its sister species the Mediterranean Flycatcher *Muscicapa tyrrhenica* (recently split from the Spotted Flycatcher) which I had the opportunity to study in Corsica and in the Balearic Islands.

O11- How to determine the detection range of acoustic recorders in terrestrial environments?

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Ecoacoustic research mainly relies on the use of passive recording devices which are deployed in complex natural environments. The detection range associated with each acoustic recorder should be evaluated 1) to avoid pseudo-replication and 2) to provide relevant proxies of biodiversity information such as species occupancy, species richness or evenness. To address this issue, we use a field-based protocol to determine the detection range of acoustic recorders in terrestrial environments. The method consists in a recording session of the ambient sound directly followed by a propagation test using a calibrated loudspeaker which is positioned away from the recording along a 100 m long transect by a 10 m step. The loudspeaker is used to play back a 80 dB SPL white noise sound. In addition a sound meter level is positioned at the recorder position to work as a calibrated reference. Such protocol was tested in a neotropical lowland rainforest (French Guiana, France) and in temperate cold mountain forest (Jura, France). The results show that the sound pressure level (SPL) of the soundscape plays a key role in the determination of the recorder detection range. The soundscape SPL varies significantly with frequencies and terrestrial environments. Sound attenuation process has been modeled as an exponential decay with two parameters depending on the propagation distance and the frequency band. Such model fit with the experimental data. Then, knowing the attenuation due to the spreading losses and the atmospheric absorption, it is possible to assess the part of the attenuation due to the environment (e.g. vegetation, ground and topography). Finally, combining the soundscape SPL with the attenuation model corresponding to the terrestrial environment, the utmost detection range could be estimated for a given frequency band and initial SPL of the source.

O12- Automatic detection of Meager's (Argyrosomus regius) chorusing activity reveals natural rhythms and noise impacts

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Many fish species rely on acoustic communication to fulfil several functions such as advertisement and mediation of social interactions. Therefore, Passive Acoustic Monitoring (PAM) can be a valuable tool to monitor activity and distribution of important soniferous fish species such as the meagre (*Argyrosomus regius*). However, PAM often involves extensive sound recordings and consequently automatic methods are invaluable tools to detect and extract relevant biological information. This study assesses the impact of boat passages on the vocal behaviour the meagre over four months in the Tagus estuary (Portugal). The Tagus estuary is an important breeding site for this species, but also holds important maritime harbours and a network of ferryboat connections. We used an automatic pattern-recognition methodology based on Hidden Markov Models to assess the occurrence of meagre choruses from continuous recordings. We further tested the impact of boat passages on meagre choruses by quantifying changes in chorus energy assessed with power spectral density. Meagre choruses were observed from 13h30 to 05h00 and were dominated by long-grunts and series of isolated pulses. The chorus onset was dependent on minimum water temperature, daytime length and lunar phase (generalized additive model, R2 = 0.74). Minimum temperature had the highest explanatory power (R2 = 0.66), with a non-linear correlation with chorus onset. On average we observed a significant reduction in the chorus energy related to the ferryboat passages. This study shows that PAM can be used to obtain relevant information on the meagre spatial and temporal use of spawning areas, and to assess the impact of boat noise on fish behaviour.

O13- SIMON | eco acoustic – Scientific Monitoring Data Management and Online Repository for Eco Acoustics

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Affordable and efficient acoustic logger like the AudioMoth pave the way for large scale audio monitoring. However, data handling and management remains challenging, especially in longrunning field studies. With SIMON we want to help monitoring projects to focus on their research without the need to create their own data management and storage solution. SIMON is a combination of hard- and software tools to extract recorded data from the audio loggers and to store them in an online data repository, accessible by a set of APIs. A portable data collector based on a Raspberry Pi 4 automatically reads the audio data once connected to the audio logger, adds metadata like date, time and location and caches them in an internal storage. The data collector is equipped with a touch screen for easy handling and runs on a standard USB power supply including portable USB power banks. Once the data collector is connected to the internet via WiFi or cable, the cached audio files are automatically uploaded to the online repository for further processing. The repository runs on a standard LAMP web server (Linux, Apache, MySQL, PHP). Besides the audio data itself, a database stores all available metadata in the Darwin Core format. Both audio and metadata are available online complying to the TDWG Access Protocol for Information Retrieval (TAPIR) for a seamless integration into existing systems. A web based user interface for data annotation will be implemented in a future version. An automated signal detection based on individual threshold levels and an AI (artificial intelligence) animal sound detector will follow in our quest to provide a full integrated audio monitoring data management solution to the scientific community.

O14- Soundscape and landscape relationship in the tropical Andes. Can acoustic complexity reflect the landscape ecological integrity?

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The tropical Andes, currently under severe land-use transformations and recognized as a priority region for biodiversity conservation, is in urgent need for rapid assessment of their landscape conditions in order to make informed decisions in management and conservation. Soundscape complexity has acquired a paramount role as a biodiversity monitoring tool as it may provide reliable information about the configuration and ecological integrity of the landscape. However, how soundscape complexity and ecological integrity are related in Andean environments, as well as the factors affecting this relationship require still a thorough understanding. We studied how the soundscape complexity reflects the ecological integrity of a heterogeneous landscape on the northern Andes of Colombia, and tested whether this relationship is affected by different spatial and temporal scales. We collected 16964 1-min acoustic recordings from 31 sampling sites between May-July 2018 and estimated nine acoustic indices (AIs) to quantify soundscape complexity. Additionally, from remote sensing data, we derived an ecological integrity index (EII) based on fragmentation, connectivity, and habitat quality indicators. Mixed-effects models were fitted to assess the relationship between each AI and the EII, including the sampling site as a random effect. Five AIs were found associated with changes in the EII, indicating higher evenness of the acoustic activity and levels of the biophonic signals in sites with higher integrity. Relationships between AIs and the EII were stronger at a smaller spatial scale and responded to soundscape daily variation. The acoustic evenness index and the number of frequency peaks were the best indicators of the changes in ecological integrity. Both AIs can be integrated with remote sensing as a powerful tool for landscape monitoring and offer new perspectives for the understanding of soundscape spatial patterns. Our results show that soundscape analysis is a promising approach for the monitoring and conservation planning of acoustically unknown Andean landscapes.

O15- Application of a sample space for the characterization of shaded coffee plantation soundscape

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The plot of the frequencies that build soundscapes (power spectrum) has been used to show some of their distinctive characteristics. The application of a discretized sample space is proposed to describe, in a concise manner, the contribution of different frequency signals in a soundscape on a yearly scale. A sample space composed of frequency and intensity combinations was used to describe the shapes of power spectrums and their recurrence. The number of elements of the sample space was set so that each element had a low probability of being found in random samples. In this way, the statistical confidence in the occurrence and recurrence of the elements is increased, making it possible to validate traits in the soundscape. According to their occurrence, it was established that there are "base", "temporary" and "sporadic" combinations of frequency-intensity. When the relative frequencies of the frequency-intensity combinations were plotted versus the number of analyzed power spectrums, it was observed that few combinations predominate in the soundscape. Further, the distribution of the relative frequencies of the combinations tends to stabilize with time; a potential function described the relative frequency of the combinations. It was found that a logarithmic accumulation curve described the relationship between the analyzed power spectrums and the detected combinations in each of the proposed frequency sections; such a function was useful to validate the sampling method.

O16- Walking in the Footsteps of Stuart Gage: My Transformation into Ecoacoustics

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There was a time when I seriously thought that studying sound in the sub-freezing temperatures of Alaska's snow-covered, subarctic winter was a fool's endeavor. The field of Ecoacoustics was undefined at the time and the science of soundscape ecology hovered in the ambiguity of competing ideas, philosophies, and uncertainty. My efforts to understand sound's role in nature felt distant and unobtainable as a doctoral student in 2009, and the methods to quantify sound and analyze it for ecological inference seemed beyond my imagination. Failure was imminent. Yet, a stroke of luck came to me in 2011 that would change my life, both personally and professionally, forever. Although I do not recall how I met Professor Stuart H. Gage, I vividly recall the impact he had on my development as a struggling Ph.D. student. Stuart was not only among the most brilliant minds I have ever encountered, his gentle nature, unwavering patience, and ability to connect with me intellectually and emotionally steered me in the direction of success. Together, we not only pushed the envelope of his own meticulously-thought out methodologies, but we accomplished what many thought was impossible. In a short time, Stuart introduced me to some of the greatest scientists and philosophers of the 21st century. I became both colleague and friend to Bernie Krause and Almo Farina, among many others. Stuart graciously introduced me to a community, a family, of like-minded scientists who not only embraced my ideas but fostered my individual growth to expand on their work in my own part of the world. Through Stuart, I became a contributing author to the first book on Ecoacoustics and an invited member to the International Society of Ecoacoustics. In his memory, I will present to you the story and the science of how Stuart changed my life and how Stuart helped me blaze a path to change the way we perceive and understand the natural world. I may fight back tears in the process. However, it will not simply be out of my sadness for losing him, but the joy and light he has brought to my life.

O17- Acoustic indices applied to biodiversity monitoring in a tropical rainforest of Costa Rica

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Acoustic monitoring is used to assess biodiversity across large spatial and temporal scales. Nevertheless, extracting meaningful information from large data sets might be exceedingly time consuming; for this reason, acoustic indices have been proposed as proxies for biodiversity monitoring. We examined the relationship between acoustic indices and bird indices in two sites at the Braulio Carrillo National Park (BCNP) with different environmental conditions (impact on the structure of the vegetation and exposure to vehicular noise along highway 32), and discuss the utility of acoustic indices as indicators for biodiversity monitoring in tropical rainforests. We sampled the soundscape and bird community (using point counts) in 12 sampling points per site, during four visits to each site from June 2017 to August 2018 . We recorded sounds continuously at dawn and dusk, and for 10 minutes each hour in between, during two consecutive days per visit; and conducted four bird counts per visit (dawn and dusk). We conducted a correlation analysis between 11 acoustic indices and 4 indices derived from bird point counts. We also used random forest to analyze the ability of all acoustic indices to predict each bird index. Alternatively, we assessed the value of acoustic indices to classify data according to the degree of forest perturbation related to highway 32. Bird abundance, richness, and diversity were positively correlated with complexity and acoustic evenness indices. However, the bird indices were negatively correlated with the acoustic diversity index. Predictions of bird indices using acoustic indices presented a low explained variance (range: 0.009 - 0.14) and a high normalized root mean square error (range: 0.22 - 0.82). The classification of the sites was conducted with a high average precision of 0.93 (sd = 0.08). Acoustic indices seem to be more promising for assessing ecological condition than levels of biodiversity in tropical rainforests.

O18- Does vegetation structure shape the acoustic features of Lincoln's Sparrow songs?

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Song variation within passerine birds has typically been explained by social interactions or local adaptations to a particular environment. In sparrows, there is evidence of songs adapting to certain vegetation structure even if theirs songs are simple or highly variable. For a less studied sparrow, the Lincoln's Sparrow (*Melospiza lincolnii*), we aimed to describe the variation on its songs' across different ecosystems in Alberta, Canada using autonomous recording units. To explain differences in acoustic features along the province, we used geographic location of songs and vegetation structure. For this, we first created a song catalog to classify song types and syllable types. Then, we measured the acoustic structure of songs and unique syllables found for each male using spectrogram and power spectra view. We performed multivariate analysis testing for the effect of space and vegetation on acoustic features. We identified 68 individuals, 69 songs and 127 syllable types. We did not find evidence of geographic structure in terms of song types demonstrating high syllable sharing across Alberta. Birds sang higher-frequency songs in open areas such as grass and shrubs. Finally, unique syllables were lower in frequency in coniferous forest (denser vegetation). Therefore, Lincoln's Sparrow adjusted their songs by vegetation type. This study is a contribution to the understanding of song variation of a common sparrow at a large geographic scale.

O19- Eco-acoustic-arts: teaching qualitative ecoacoustics through sonic arts, birds & environmental sensitivities

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Teaching qualitative ecoacoustics through eco-acoustic arts opens up possible pathways for undergraduate students to develop deep and broad ecological sensitivities and knowledges. Focusing specifically on more-than-human birds sounds and engaging the core concept of ecoacoustics as the ecological investigation and interpretation of environmental sound, the course *Sonic arts, birds & environmental sensitivities* was created and taught within the context of a music department in a research university (University of California, Santa Barbara). Through the concept of sounding as an inspirational process to explore entanglements of scientific research and cultural formations, students used a range of qualitative and quantitative methods, practices and processes, including sensory ethnography, ethography, uses of ArcGIS (as sound mapping), and digital technologies. In particular, the course enabled students to undertake fieldwork during the COVID-19 lockdown, utilizing their own recording and listening technologies to engage with birds in their locale, translating these ecoacoustic data into embodied and emplaced knowledge, and into communicative, artistic responses. Recognizing the poetic-political potential of eco-acoustic-arts as activism, this course provides a model for analogous contexts in multiple educational settings integrating environmental arts and sciences.

O20- Zeuneriana marmorata and Uromenus annae (Insecta: Orthoptera): songs from the verge of extinction

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Zeuneriana marmorata (Fieber, 1853) and *Uromenus annae* (Targioni-Tozzetti, 1881) were once believed to be extinct or nearly so. Both are inserted in the IUCN Red List of European Orthoptera. Z. marmorata ranges in the Adriatic coast of North East Italy and Slovenija inland. Its presence was dramatically affected during the past by habitat loss and pesticide use. The remnant populations are now being studied by an international conservation project. The bioacoustic comparison of the male calling song from different populations is investigated to clarify any difference between populations. *Uromenus annae* is a striking species endemic of Sardinia (Italy) were it lives in scattered populations. Thought to be extinct, it has been rediscovered in 2018 and its male calling song has been recorded for the first time. This instigated further researches that found more living populations.

Thursday 24

O21- Miniature recorders embedded in radio transmitters help to elucidate behaviours and inform monitoring practices in a New Zealand endemic flightless bird

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We describe the development of a miniature acoustic recorder that can be fitted into the radio transmitter of the North Island Brown Kiwi (NIBK | Apteryx mantelli, Bartlett), a New Zealand native nocturnal, ground dwelling bird. Our aim is to obtain sufficiently accurate data to determine whether this species produces recognisable individual calls. As well as providing useful information about behaviour, this will also assist in the establishment of a link between between the number of vocalisations detected and the number of calling birds present. We have equipped birds from two high density populations with these 'microrecorders' and deployed traditional ARUs in both their resting and foraging areas. By comparing the vocal activity of individuals with the community level we can inform acoustic based population density estimates, providing a method to establish both the number of silent birds and the distribution of vocalisations over the vocal individuals. Employing these devices on a larger scale, including multiple kiwi populations of known different densities could eventually lead to (passive) acoustic population density estimates, which would be useful for conservation decisions.

O22- Sound event detection in long-term recordings using changepoints

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Passive acoustic recordings have emerged as an efficient means to monitor populations of vocalizing species, and also provide unique data for studying animal behaviour in natural environments. However, the processing of such data is currently limited by the ability to efficiently and reliably detect target sounds, which are often sparse in long-term recordings and overshadowed by environmental noise. We present a new sound event detector based on changepoint theory. A wavelet pre-filter is used to extract a set of frequency bands from the recordings. The filtered data is then analysed to localise any changes in power. Transient signal changes are separated from longer shifts in the background noise, using a maximum length bound. Training requires only a small amount of data to set this bound and other parameters. In contrast to existing methods, this framework allows us to establish theoretical guarantees of the detector's accuracy and computational complexity. New statistical and algorithmic developments to support these claims are presented. We applied the method to acoustic surveys of two bird species in New Zealand: Australasian bittern and little spotted kiwi. The detections by the proposed and reference methods were reviewed, and used in a population inference method (spatial capture-recapture). Compared to commonly-used detectors, the proposed method consistently produced fewer false alarms, leading to two-fold higher precision of the inferred population size. This shows that survey data can be analysed more efficiently if the workflow design is driven by the ecological goals. Potential application examples for other types of sounds are demonstrated as well.

O23- Individual recognition in rifleman, Acanthisitta chloris: Machine learning classification helps identify individual bird calls from audio recordings

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Machine learning classification is increasingly used to identify individual bird vocalizations from audio recordings. Machine learning classifiers capable of recognizing individual vocalizations are essential tools to answer questions about animal vocal behaviour such as seasonality of vocalizations and vocal interactions between individuals. In our study, we created machine learning classifiers to recognize individual birds in hundreds of hours of recordings. Our aim is to understand how rifleman recognize each other's vocalizations. We hypothesized that if individual vocal recognition is accurately performed by machine learning algorithms, then similarly, birds should be using similar vocal parameters to differentiate between one another. We first developed and trained a machine learning classifier using zebra finches vocalizations. We then collected audio recordings from wild rifleman, a basal passerine species endemic to New Zealand whose vocal behaviour at nests is not well known. We found that our trained classifier successfully discriminated between individual zebra finches. We found that random forest models based on Mel-frequency Cepstral Coefficients (MFCC) performed better than Keras Models which are call-type independent models working regardless of what call type zebra finches were making. We predicted that our classifier will perform equally on discriminating between individual rifleman's nest calls. In order to gain new insight into animal vocal recognition and vocal behaviour, machine learning classifiers are a tool that can help identify individual bird calls.

O24- Diversity favours the old: metrics of avian diversity increase in aging regrowth Acacia woodlands of semi-arid eastern Australia

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Understanding how native fauna use regrowth vegetation is critical because of increased land clearing rates and biodiversity loss, yet it remains poorly studied in Australia's semi-arid regions. This study used acoustic sensors to monitor avian diversity in three different age classes (new regrowth <15 years, intermediate regrowth 15-30 years, and old growth >30 years) of Acacia dominated, predominately mulga (*Acacia aneura*) woodlands in south-west Queensland. Manual analysis of 300 random minutes from 15 days of dawn recordings per site made during 2017 revealed that species richness, functional diversity and phylogenetic diversity increased with time since last clearance, with statistically significant differences between new regrowth and old growth. Each age class had unique species, yet intermediate regrowth and old growth shared a large number of species suggesting a convergence in species composition. Overall, results of this study show that while old growth vegetation sustains the highest level of biodiversity, intermediate and new regrowth still support a range of bird species. Therefore, regrowth mulga vegetation should be protected as it represents important habitat for avian biodiversity in semi-arid Australia.
In a follow-up study in the three age classes, recordings collected during the same time period over three years (2017-2019) were analysed using 18 acoustic indices. GLMMs revealed that three indices (mid frequency cover, high frequency cover and acoustic complexity) showed some relationship with avian species richness. However, modelling revealed that random effects (site and time) explained more variation than species richness. Remote sensing greenness data (soil adjusted vegetation index) varied over the three years reflecting local climatic changes and ephemeral conditions. Further studies are required to determine whether ecological factors, such as shifts in avian community composition and functional groups, insect activity, and phenology, are drivers of the patterns observed.

O25- The soundscape patterns of urban spaces with varying degrees of connectivity in metropolitan Seoul

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Urban green spaces differ in size as well as in connectivity. Theories predict that species richness may increase with size or connectivity of habitats, but the effects of size and connectivity on soundscape are not well studied. Using GIS and Graphab, we selected 4 sites with four classes of area (1000, 10000, 100000, over 1000000 m2) and four classes of connectivity, as well as habitat type, in metropolitan Seoul. To record soundscapes of these sites, we used Audiomoth 24h twice a month unitl may to august in 2019. We measured 10 α indices (spectral entropy, acoustic complexity index, acoustic evenness index, acoustic richness index, normalized difference soundscape index, acoustic entropy index, bioacoustics index, acoustic diversity index, amplitude index, temporal entropy) for each 24h recording. The acoustic complexity was low in sites with low connectivity. Size was a significant factor for α indices only between the biggest sites and the other lower classes sites. Thus, patterns of α indices during daytime were similar among sites with three lower classes of size. Our findings show that connectivity is more critical for determining patterns of soundscape in relatively small urban green spa

O26- Biotremology as a new tool of ecoacoustics

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Biotremology is the study of the production, perception, and transmission of mechanical vibrations through a substrate. Research in the field of biotremology has contributed to improve the understanding of insect behavior, ecology, and evolution. However, due to the technical challenges encountered in field trials, less research is devoted to investigating the interactions between insect vibrational signaling and the environment. We developed and tested an approach that could be implemented as a monitoring tool of insect vibrational signals occurring in an agroecosystem and evaluated the effect of environmental factors on the vibrational signaling of the insect community composing its vibroscape. The approach consisted of recording vibrational signals throughout the day and in different parts of an organic vineyard. Results show that the signaling activity was highly influenced by environmental factors. High temperature and wind velocity represented unsuitable conditions for insects which therefore significantly reduced their signaling activity. The approach allowed us to determine the daily signaling pattern of the two vineyard pests Scaphoideus titanus and Halyomorpha halys and the spatial occurrence of their signals. Our conclusion is that biotremology techniques could be profitably used, as a new tool of ecoacoustics, to monitor not only quantitative information but also biodiversity associated to insect vibrational signaling in ecosystems. In particular, in agroecosystems, this method could be employed to compare the environmental quality of cultivated areas at different management systems.

O27- *Sonosfera* – An ecoacoustic theatre for science-based listening experiences

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Several field recording campaigns have been conducted, over the past 19 years, in undisturbed primary equatorial rainforests in Amazon, Africa and Borneo, within the scope of the project "*Fragments of Extinction* - the sonic heritage of ecosystems", generating complex three-dimensional data sets for archival, ecoacoustic analysis and public sharing. Due to the extreme hi-definition and space-preservative characteristics of the multichannel data collected, these soundscape recordings of animal communities required an increasingly sophisticated technology to be then properly rendered to audiences. The Eco-acoustic Theatre has been developed as a concept and instrument to fill this gap and enable science-based listening experiences of entire ecosystems.
From the first project in 2006, a series of different realizations of permanent and mobile spaces (S.P.A.C.E. Soundscape Projection Ambisonics Control Engine at Conservatorio G. Rossini, IT; Mobile Space at ECSITE-MUSE, IT; Soundscape Theatre at Naturama Natural History Museum, DK) have constituted the engineering basis for the construction of the *Sonosfera (*Sonosphere*)*, a functional theatre for ecoacoustics which optimizes all passive-acoustics and electroacoustic characteristics, employing the most advanced custom-built audio technologies. This mobile 16 tons theatre is a 10-meter diam. amphitheatre which hosts 60 people at the centre of a 45 loudspeakers array and an ultra hi-definition 360° screen for scientific visualizations.
The *Sonosfera*® opened in December 2019 to the public in Pesaro UNESCO Creative City of Music - Italy; it represents a unique spherical 'machine' to enable both sensorial perception of complex sonic habitats and visualization of spatial and spectral characteristics of ecosystems.

O28- Polycultures show higher acoustic diversity than monocultures in a Panamanian tree diversity experiment

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The analysis of soundscapes offers easy, rapid and sustainable methods for assessing biodiversity. Recently the quantification of regional or global acoustic variability in sounds and the analysis of soundscapes has evolved into an important tool for biodiversity conservation, especially since case studies confirm relationships between land-use management, forest structure and acoustic diversity. Tree diversity experiments like in Sardinilla, Panama examine the influence of tree species richness on various facets of diversity and ecosystem functioning. Diurnal sound recordings made in dry and wet seasons, combined with the experimental design of different tree species mixtures, offer possibilities to also investigate acoustic diversity as a function of diurnal and temporal patterns as well as vegetation structure. In the frame of this study, different acoustic indices were calculated to investigate acoustic diversity within (α-diversity) and between different tree species mixtures (β-diversity). Acoustic α-diversity was highest at night, dusk and dawn, which confirmed former studies stating dusk and dawn as being acoustically richest, and could be related to vocalizing insect species being most active at night and dominating the vocalizing community in Sardinilla. The dry season was more acoustically diverse than the wet season, which might be due to the dominance of insects rather than amphibians. During all seasons and day phases, except for day-time recordings during the dry season, monocultures showed a lower acoustic diversity than polycultures (2-4 tree-species-mixtures). This aligns with findings that monocultures had lower forest structural diversity than polycultures. Beta-diversity was highest between monocultures and polycultures. In conclusion, this study confirms that biodiversity, as measured by acoustic diversity, of tropical plantations can be substantially increased by planting two or more tree-species instead of monocultures.

O29- Assessing the presence and species richness of owls and woodpeckers through bioacoustics in two differently managed Alpine forests

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Birds present large differences in species-specific responses to forest features such as structure and composition, and therefore they act as an indicator of forest ecosystem biodiversity. Woodpeckers and owls, specifically, are considered important forest naturalness indicators and their presence reflects those of numerous other forest-dwelling species. Because of their habits and behaviour, they are more difficult to detect than the passerine species, and therefore the implementation of the bioacoustics discipline is suited to the survey of such taxa. In the present study we collected data about the presence and species richness of owls and woodpeckers in relation to the main forest structure and composition variables (basal area, dominant height, tree species diversity, living trees' vegetational conditions, canopy closure percentage, total deadwood volume, decomposition stage) in two forest sites which share similar ecological characteristics, but differ in terms of management: Cajada (non-intensively managed) and Tovanella (abandoned). Both Cajada and Tovanella forests report the presence of bird species belonging to the taxa of woodpeckers and owls, which are indicators of the forest at late-successional stages. In Cajada we contacted woodpeckers and owls a significantly higher number of times than in Tovanella, and the decomposition stage of deadwood and the level of canopy closure seem to the main explanatory factors of such results. Since management practices in Tovanella have been only recently abandoned we think that our results might change in the future. Therefore, further research is needed, also to better assess how sustainable forest management might conserve key forest features which are crucial for the thriving of most demanding owls and woodpeckers.

O30- Does noise matter ? Passive Acoustic Monitoring reveals the co-occurring presence of two threatened sympatric vocal species (*Sciaena umbra* and *Umbrina cirrosa*; Sciaenidae) in highly anthropized Venice inlets

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Human impacts on marine ecosystems are accelerating, and the number of fish species listed in the Red List is growing. In the Mediterranean Sea, seven of the 10 bony fishes defined as Threatened by the IUCN are known to be vocal, including the shi drum (Umbrina cirrosa) and the brown meagre (Sciaena umbra). As a result, non-invasive Passive Acoustic Monitoring (PAM) can be used to pinpoint their distribution at sea. This is of particular interest since these species are closely related, elusive, sympatric, vocal sciaenids.
During summer 2019, three PAM surveys were conducted on a total of 40 listening points along the three tidal inlets of the Venice lagoon (Italy), which connect the open sea to one of the principal ports of the Northern Adriatic Sea. Here, the calls of both species have been recognized according to their temporal features: shi drum sounds were made up of a lower number of longer pulses with a different envelope, repeated at a lower rate than those of the brown magre. Call discrimination highlighted a partially overlapping distribution of the two species, inhabiting these highly anthropized inlets. Furthermore, S. umbra was found to emit longer sounds, with a higher number of faster repeated pulses during the chorus; these sound features are related to spawning activities in captive Sciaenids and were therefore used as proxy of spawning events in the study area. A cluster analysis based on S. umbra vocalizations separated the listening points in three areas; the areas in which vocal activity was highest were also characterized by the highest noise levels and number of vessel passages. This indicates that S. umbra spawning grounds are located in the noisier areas of the inlets, despite vessel noise is known to affect the efficiency of fitness-related behaviors. Results are discussed in a conservation perspective.

O31- Data mining soundscapes for Orthoptera monitoring: challenges and opportunities

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The majority of acoustically signalling species are insects. Orthoptera often dominate tropical soundscapes : most o f the 7,720 known katydids (Tettigonioidea) and 5,780 crickets (Grylloidea) stridulate [1]. Adding about 4,000 short horned grasshoppers singing mainly in grasslands, there is an estimated total of 17,500 sound producing Orthoptera, plus hitherto undescribed species. Ecoacoustic data sets are a most valuable data source for Orthoptera bioacoustics: once properly archived, they could be (re)used for detection of threatened species or data mining for hitherto unidentified Orthoptera song patterns. Here I present some general features of Orthoptera songs in complex soundscapes from Borneo and South America, including ultrasound recordings made with programmable audiomoth recorders. Up to 20 Orthoptera signals were detected in a single sound track, from overall sets of about 100 insufficiently identified Orthoptera species at the respective localities. In contrast, soundscapes from Greece allow species determination thanks to reliable, well curated song libraries and a well-known limited set of species. It is evident that these data are highly relevant for Redlist Threat Assessment, monitoring of conservation measures and species discovery. Taking into account the high number of ecoacoustic projects worldwide, there is a huge potential for datamining Orthoptera songs, if ecoacoustic datasets would be freely accessible. While bioacoustic sound archives can be federated via Global Biodiversity Information Facility (www.gbif.org) protocols, this is much more difficult for ecoacoustic datasets, due to their size and complexity. I describe requirements for data management such as stable URLs and metadata annotation within snippets extracted from soundscape recordings, which could serve as a first step towards an acoustic file interchange protocol, resulting in improved data sharing and efficient re use. [1] Higher classification and species numbers from Cigliano, M.M., H. Braun, D.C. Eades & D. Otte. Orthoptera Species File . Version 5.0/5. 0 9/02/2020] http://Orthoptera.SpeciesFile.org

O32- Using acoustic monitoring to measure the effect of forest management intensity on bird and bat communities

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Resident birds in boreal forests can serve as indicators of habitat quality and are often species of conservation interest, particularly in multifunctional forests also used for timber production. It would therefore be useful to establish reliable methods for monitoring their presence and activity during the critical winter season and to evaluate the degree to which structural features in forest patches provide habitats useful for their winter survival. In establishing these methods, we will have efficient ways to identify patches of high conservation value for birds. We employed three monitoring approaches in 19 sites in a Swedish boreal forest landscape to identify the optimal method for monitoring resident birds in winter. We conducted a vegetation survey, traditional point count surveys and collected automated acoustic recordings from December - February, 2019. First we directly compared species richness values derived from point count and bioacoustic monitoring methods. Bioacoustic species identification yielded additional metrics of bird activity that point counts cannot: the number of cumulative bird identifications per site (No. Visits), number of observed flocking events per site (No. Flocks), and the number of recordings containing multiple species (non-flocks) simultaneously (No. Multiple Birds). We tested the response of all point count and bioacoustic metrics to variables of structural heterogeneity and complexity. Lastly, using an ecoacoustic approach, we calculated six of the most common acoustic indices and tested if any could effectively reflect the relationships between bird activity and vegetation structure described above. This is the first winter acoustic study to monitor bird assemblages in detail; it employed both bioacoustic and multi-index ecoacoustic approaches, and the results we will present provide strong evidence that automated acoustic recording can be an effective and superior method for monitoring resident forest birds in winter, providing a high-resolution ability to identify links between bird diversity and different components of structural complexity.

O33- Trade-off between song complexity and colorfulness in parid birds

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Complex singing as well as plumage coloration of male birds are honest signals for potential partners and provide information about the males‚Äô quality. To function as honest signals, both traits must be costly for the males. Due to limited resources, we expect a trade-off between the expression of both traits. This study researches the relation between song complexity and plumage coloration in tits (Paridae). These belong to the songbirds (Oscines) and show great variability in song and plumage coloration across species. For statistical analysis we implemented a phylogenetically generalized model of least squares containing potential explanatory variables. In the best model, body size besides colorfulness had a negative impact on song complexity: Large colorful tits sing less complex and vice versa. This result supports the hypothesis of a trade-off between costly traits and their likely intense signal function. This study contributes to the better understanding of how sexual selection influences diversification of traits.

O34- The application of Direction Of Arrival methods for animal localisation

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Multilateration with Time Difference Of Arrival (TDOA) is the standard method for locating animals from their calls. An alternative method is to use compact microphone arrays, measuring only a few millimetres in size, to obtain Direction Of Arrival (DOA) measurements. Locations are found by triangulating angle measurements from two or more arrays. A ground location can be found from two arrays positioned on one edge of the monitored area. This is useful if the site has restricted access, for example one edge of a wetland area or the bank of a lake. There is particular benefit for locating flying animals (bats and birds). We have developed a two-dimensional array that measures azimuth and angle of elevation. A point in space can be found by triangulating the unit direction vectors recorded by each array. We will show models of the error estimates for two- and three-dimensional localisation methods. We will also introduce ‘Flightpath’, a web application that is being developed to process DOA recordings for animal localisation.

O35- Songs of a fishing bat: echolocation call variation of the greater bulldog bat across the Neotropics

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Climate is a crucial factor for the evolution of bat echolocation calls, mostly due to its effect on atmospheric sound absorption. Indeed, according to the Sensory Drive hypothesis species' echolocation call frequencies will vary along the latitudinal gradient in response to different conditions of atmospheric attenuation. The lineages of Neotropical fishing bats are perfect models to test this hypothesis. So, here, by means of acoustic monitoring and analysis, echolocation calls from bat populations of the greater bulldog bat, Noctilio leporinus, from North, Central and South America will be used to test if differences in humidity and temperature across the geographic and climatic ranges of the species will result in different call frequencies. Despite the fact that in the last years the use of acoustic monitoring has increased in the Neotropical region, studies on echolocation behaviour are still very scarce. Indeed, the variation in the echolocation calls of the greater bulldog bat along its geographic distribution has never been studied. The results of our study will shed light on how bats adapt their echolocation behaviour to local weather conditions and on the subsequent implications for lineage diversification. Ultimately, this will potentially help us understand how other bats will cope with present and future climate changes and to identify priority populations and habitats for conservation efforts.

O36- Bats of the neglected Brazilian-Uruguayan savanna: occupancy, diversity and conservation

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The conversion of open habitats into monoculture forest systems or their degradation through intensive use for agriculture and livestock production affects the activity, diversity and occupation of organisms at different spatial scales. The BrazilianUruguayain savanna is the least officially protected of all Brazilian biomes. There is a significant gap of knowledge on bats of these South American grasslands, especially in what concerns aerial insectivores. Indeed, no acoustic monitoring has ever been made in the region, knowingly the best method to detected this guild, that potentially makes up the majority of bat fauna of the region. We monitored 75 sites placed 1.5 km apart, from November 2019 to January 2020. We calculated different landscape metrics to determine the degree of connectivity in each site. The sites were grouped into scarcely, medium and highly connected, composing the classes of land-use in concentric spatial buffers from 100 m to 1000 m around each sampling site. We sampled bats using automated sound-detectors (Audiomoths), programed to record cuts of 15 seconds every two minutes, for five days in each site. We also coupled automated temperature and humidity sensors to each active Audiomoth to obtain detailed information on the weather conditions associated with each sound record. We obtained over 20,000 hours of recordings, and presently the acoustic data is being processed in the laboratory. Using the history of detection and non-detection of each species, we will build hierarchical occupation models, using the landscape variables as occupancy predictors and the microclimatic variables as detection predictors. Our results should contribute to fill several knowledge gaps on bat occupancy, ecology and diversity patterns in the Brazilian-Uruguayan savanna. In parallel, we should be able to increase the acoustic library of Brazilian bat calls allowing the expansion of the horizons of bioacoustics research in the country.

O37-Acoustic measures of bird communities in a thinned and burned coastal plain pine forest

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In the face of climate change and urban development land managers are faced with increasingly difficult choices on how to maintain the biological integrity of protected areas. To support the decisions made by protected area managers, tools and methods to quickly measure and assess trends and outcomes from management actions are needed. Our current study in an Atlantic seaboard coastal plain forest examines how prescribed fire and timber harvesting impact bird diversity and singing activity using a soundscape analysis. In 2008 The Nature Conservancy started to restore sites planted in loblolly pine (Pinus taeda L.) using controlled burns and timber harvests at the Nassawango Creek Preserve, a protected conservation area. This area is visited by a high number of migratory birds and has been designated an Important Bird Area by the Audubon Society. This setting allowed us to compare bird communities in thinned and burned stands to unmanaged areas with similar forest types. We found a higher quality soundscape as measured by the mean normalized difference soundscape index (NDSI) in the thinned and burned site with lower mean trees per hectare. In addition, the thinned and burned forest had higher mean acoustic complexity and bioacoustic indices (ACI and BI). We also found that since 2005, the population of prairie warbler (Setophaga discolor) declined at the unburned site as the canopy closed and became more homogeneous. In contrast, prairie warbler continues to persist in nearby burned forest of approximately the same age. Prescribed fire combined with targeted timber management can increase the available habitat conditions required by different species of birds in a loblolly pine plantation.

O38- Monitoring vessel use and characterizing acoustic species assemblages in the soundscapes of two Australian marine parks

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Soundscape ecology characterizes acoustic interactions within an environment, integrating biological, geological, and anthropogenic sound sources. In this study we assessed the overlap of biological sound sources and vessel transit in time and frequency to establish a baseline measure of soundscapes within two marine National Park Zones (NPZs) along the east coast of Australia: Cod Grounds Marine Park and Solitary Islands Marine Park. Although transit through the areas and general use is permitted, fishing and other extractive activities are prohibited within the NPZs, and acoustic recordings were originally used to inform park managers of vessel activity patterns. This study presents a noninvasive, high resolution method of simultaneously assessing human activity and the presence of multiple species. In each of the NPZs, recorders were deployed twice during the austral winter (33–35 days, 2018 and 60-69 days, 2019) and once during the austral summer (35–71 days, 2018–2019) to determine whether the soundscape of each site exhibited seasonal differences in anthropogenic or biological sound sources. The resulting acoustic recordings allowed us to determine hourly presence of sounds throughout the recording periods between 20 Hz and 24 kHz in frequency. Biological sources at both sites included dolphins, continuous snapping shrimp, diel patterns of fish choruses, and seasonal presence of singing humpback whales. Anthropogenic sources were largely dominated by vessel transit, which was further classified into distant vessels and closer approaches likely within the NPZ. Additional deployments are forthcoming in more remote marine parks aimed at understanding patterns of vessel use and soundscapes throughout diverse habitats.

O39- Assessing soundscape disturbance through hierarchical models and acoustic indices: a case study on a shelterwood logged northern Michigan forest

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Assessing the effects of disturbances on wildlife is a necessary conservation task. The soundscape is a critical habitat component for acoustically communicating organisms, but the use of the soundscape for assessing disturbance impacts has been relatively unexplored until recently. Here we present a broad modeling framework for assessing disturbance impacts on soundscapes, which we apply to quantify the influence of a shelterwood logging on soundscapes in northern Michigan. Our modeling approach can be broadly applied to assess anthropogenic disturbance impacts on soundscapes. The approach accommodates inherent differences in control and treatment sites to improve inference about treatment effects, while also accounting for extraneous variables (e.g., rain) that influence acoustic indices. Recordings were obtained at 13 sites before and after a shelterwood logging. Four sites were in the logging region and nine sites served as control recordings outside the logging region. We quantify the soundscapes using common acoustic indices (Normalized Difference Soundscape Index (NDSI), Acoustic Entropy (H), Acoustic Complexity Index (ACI), Acoustic Evenness Index (AEI)) and Welch Power Spectral Density (PSD) values. We build two hierarchical Bayesian models to quantify the changes in the soundscape over the study period. Our analysis reveals no long-lasting effects of the shelterwood logging on the soundscape as measured by the NDSI, but analysis of H, AEI, and PSD suggest changes in the evenness of sounds across the frequency spectrum, indicating a potential shift in the avian species communicating in the soundscapes as a result of the logging. Multiple model validation techniques (i.e., comparison of parameter estimates and the widely applicable information criterion (WAIC)) reveal our proposed hierarchical Bayesian models outperform more simple models used for hypothesis testing. Acoustic recordings, in conjunction with this modeling framework, can deliver cost efficient assessment of disturbance impacts on the landscape and underlying biodiversity as represented through the soundscape.

O40- Passive acoustic monitoring for identification and location of a migratory fish spawning areas in a tropical Andean river

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Hydropower expansion poses multiple threats to biodiversity of rivers around the world. One of the most notable aspects is the loss of migratory fish spawning areas due to fragmentation and changes of the environmental characteristics in such areas, affecting fish recruitment. To apply comprehensive management strategies for migratory fish in rivers basins impacted by hydroelectric development, it is necessary to identify and locate their spawning areas. These areas of importance for fish reproduction have been identified, among other techniques, through passive acoustic monitoring (PAM), however there are very few cases of PAM application in tropical river systems. Our objective in this project was to bioacoustically characterize spawning sounds of a migratory fish species (Prochilodus magdalenae) and validate PAM to identify and locate spawning areas of this fish in the Magdalena River Basin, Colombia. As a result of our project, the spawning sounds for this species was characterized and two spawning sites were successfully located in the Magdalena River Basin. Train of pulses presented a dominant frequency, train duration, total number of pulses by train and interpulse interval values of 399 Hz, 2.3 s, 48.6 pulses and 49.0 ms, respectively. It is concluded that through PAM spawning areas of Prochilodus magdalenae can be located in the Magdalena River Basin. A greater number of soniferous fish species could be bioacoustically characterized in the area, providing important data that helps to prioritize conservation and management efforts for spawning key areas.

O41- Musical use of nature sounds - Perspectives from the second part of the 20th century

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Ecoacoustics has been developed as a unique mix of science and arts. Here, we aim at understanding and exploring why and how nature soundscapes are embedded in musical practices. More specifically, we worked on the concept of "musicality". Why are nature sounds considered to be more musical than anthropophonic sounds? How does the use of nature sounds in music since the second part of the 20th century deconstruct and question the concept of "musicality"? These essential issues about the interweaving of music and sounds from the environment, which transcend cultural boundaries, have been addressed by a study based on a review of musicological, ecoacoustics and ethnographic literature, and on interviews with field recorders and composers using nature sounds in their music. We identified three ways of considering musicality: as an acoustic structure, as a human process, and as a listening posture. We challenged the hypothesis that nature sounds possess an intrinsic structural musicality. We thus discussed the concept of harmony, melody, and rhythmic of natural sounds. We then questioned the way in which natural sounds are transformed into music, analysing the different processes, steps, and artistic styles of producing. Eventually, we discussed whether a specific posture of listening leads to finding musicality in nature sounds. We exposed different types of listening described by various authors, and commented on the notions of imagination, abstraction, and realism in the Western concept of musicality. The combination of ecology and social sciences leads to a unique interdisciplinary and creative approach to understanding how environmental sounds and music are connected.

O42- The rise and fall of Biophony and the drivers of the acoustic space

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Ecoacoustics targets the properties and dynamics of environmental sounds as its main analytical unit. Biophony, being the collection of animal sounds, is perhaps the most enigmatic component of soundscapes. It contains multifaceted information about biodiversity, ranging from the identity of organisms to the output of eco-evolutionary processes. Here we begin by presenting the raise of research of animal ecology with passive acoustic monitoring in terrestrial ecosystems. We synthesize main aspects in almost two decades of research for distinct biological groups, research subjects, geographical distribution, and survey designs. Next, we address traditional hypotheses addressing the acoustic component of ecological communities that are considered theoretical backgrounds in ecoacoustics. Our approach combined species composition, phylogenetic, acoustic parameters, and body-size relationships of anuran signaling assemblages across gradients of environmental heterogeneity in the Pantanal wetlands of Brazil. First, we found little support for the hypotheses of acoustic partitioning and acoustic adaptation in structuring the acoustic space of assemblages,
arguing for the fall of these traditional hypotheses. Second, fine-temporal variation in community-wide activity was associated with environmental heterogeneity and phylogenetic relatedness, suggesting potential trade-offs between spatial and temporal partitioning. Altogether, our findings underscore the importance to address the ecological context of communities to better comprehend the dynamics and drivers of the biophonic component of soundscapes.

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O43- Singing in a noisy ocean: can male humpback whales cope with natural and anthropogenic noise?

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The soundscape in the shallow waters off Eastern Australia is characterised by a variety of natural and anthropogenic sources. Amongst these, wind generated noise and vessel noise are constantly present, although their levels are variable. In the winter months, humpback whales travel through this area during their annual migration between feeding and breeding grounds. While in transit, the males produce complex series of vocalizations, known as songs, believed to be a reproductive display. Underwater noise can mask whale songs limiting their range and reducing signal clarity. This project investigates whether singing whales modify the characteristics of their vocalizations to compensate for changes in the soundscape to maintain efficient communications. Underwater noise and humpback whale songs were recorded using a fixed hydrophone array deployed off the Queensland coast. Due to natural variability, the recording period provided a range of wind noise levels. At the same time, a series of controlled experiments was carried out to expose nearby whales to variable levels of vessel noise. The recordings were analysed to look for correlations between the characteristics of the songs and noise levels. Results showed that when the soundscape was dominated by the wind, singing whales compensated for variable levels of noise by adjusting the source levels of their songs, but they did not modify the spectral and temporal parameters. During the experiments, when vessel noise was dominating the soundscape, there was no correlation between song characteristics and vessel noise levels; however, the singers adjusted their source levels to the underlying wind noise. This study found that male humpback whales do not sing as loudly as possible to communicate their fitness or to maximize their communication range and that, although they do not modify their sounds to compensate for anthropogenic noise, they regulate their songs based on the natural components of the soundscape.

O44_ Developing a fine-scale soundscape spatial model for measuring biodiversity in a semi-arid landscape

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Vegetation composition and structure and water availability are key determinants of the faunal communities found within semi-arid and arid ecosystem regions. This research will examine how soundscapes vary across spatially distinct but proximate vegetation communities in semi-arid Australia and identify the main drivers of this variation. Acoustic recorders were deployed at Bowra Wildlife Sanctuary in semi-arid western Queensland, Australia, along a transect at 200m intervals for 24 hours in August and October 2019. Bowra Wildlife Sanctuary has a mostly flat (low elevation) landform, and is dominated by Acacia woodlands, tussock grasslands, and Eucalyptus coolabah woodlands fringing ephemeral creek lines. Deployment points were selected using two main criteria: (1) to maximise the captured variability across multiple vegetation communities, and (2) to consider proximity to water, which is a valuable resource in semi-arid regions. Local weather data were also collected, as well as surrounding vegetation community and bird species richness data. Acoustic recordings were analysed using a suite of acoustic indices and clustering techniques. Preliminary data will be presented showing how cluster data can be combined with environmental variables to build a spatial model indicating the locations and features driving soundscape variability. Maps will be produced showing the soundscape at different points, and the soundscape patterns at different times of the day.

O45- What does Atlantic Forest soundscapes can tell us about landscape?

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The ecoacoustics approach for environmental recordings analysis is used to understand and identify big patterns related to different sound sources, like animals, humans and the environment itself. Sounds can vary according to several features that can be on its nearby surroundings or in a distance, therefore they are very much reliant on scale. Since humans are changing the environment so much and we cannot account for all those changes in the same speed as they happen, we need fast evaluation tools, such as remote sensing and acoustic monitoring (the equivalent of spatial remote sensing for sounds). Considering that the scale of effect was never measured for soundscapes before, we tested different buffers sizes to assess at what scale different acoustic indices were responsive to. Also, we tested how natural vegetation cover influenced different acoustic indices. We recorded environmental sounds in Atlantic Forest areas during three months on the rainy season. Then we calculated different acoustic indices and the percentage of natural vegetation cover in different scales. Our hypotheses were corroborated by our results: different indices respond to different scales and their medians varied according to the amount of vegetation cover on the surroundings. More studies are needed in less fragmented areas, to test indices behaviour in a continuum, but we consider this work an important start to understand acoustic indices behaviour in tropical areas, especially in such degraded area as Atlantic Forest.

O46- What can Mathematics teach us about the spectrogram?

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Being easy and quick to read, the spectrogram is central to data analysis in bioacoustics. However, we rarely think about how to take advantage of its properties. When computing a spectrogram, we use Fourier Transform to turn a sound wave, a function of pressure and time, into a picture of energy in time-frequency plane. This picture is usually used to characterise and classify animal sounds or to design an automatic recogniser.
We will discuss how a deeper understanding of the spectrogram can improve the analysis of real word data. As an example, we will present our work on the echolocation of the two New Zealand bats species: Lesser short-tailed, Mystacina tuberculata, and Long-tailed, Chalinolobus tuberculatus. We worked with data collected using the recorders at the disposal of New Zealand Department of Conservation (DOC). These devices record suspected bat pass into a compressed version of the spectrogram which retain sufficient information to recognise the echolocation calls. We will demonstrate a Convolutional Neural Network algorithm for the automatic detection and classification of these calls. Moreover, we will discuss how we can retrieve the lost original sound with spectrogram inversion. This technique is based on the mathematical definition of the Fourier Transform, which is the most exploited time-frequency representation (TFR) of signals. However, it is not flawless. Due to the uncertainty principle, there are limits in the time-frequency resolution, that cannot be corrected by its hidden parameters (e.g. window length, type or overlap). We will briefly introduce other mathematical tools that can be used as TFRs, discussing how to compare them and what can be the future developments.

O47- Exploring phenological asynchrony between avian diversity and vegetation in temperate deciduous forests through bioacoustic monitoring and camera trapping

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Climate change has had significant effects on the phenology of spring-time vegetative growth and bird reproduction, however, increasing evidence exists that reproduction in long-distance migratory bird species is not keeping pace with the emergence of vegetation in temperate habitats. The aim of this study was to explore whether such asynchrony could be occurring in Scottish deciduous forests using acoustic monitoring and camera traps to track the phenologies of migrant birds and vegetation growth from January to July 2019. A series of images was obtained using time-lapse settings of camera traps to determine a 'greenness score' as vegetation emerged from winter dormancy. Simultaneous bioacoustic monitoring was used to estimate the arrival date of eleven species of singing passerine and the difference between green-up and arrival was calculated to measure the phonological interval. Acoustic indices were also calculated and compared against avian and invertebrate diversity, measured through mist-netting and trapping studies respectively, to determine whether acoustic diversity could be an effective measure of overall biodiversity before being compared with greenness index. The Bioacoustic Index was determined to be the most promising index for estimating avian diversity. The Bioacoustic Index and Normalised Difference Soundscape Index also showed strong positive associations with photoperiod, likely as a consequence of increased daylength triggering mating behaviour and increased bird song in the soundscape. Short-distance migrant species tended to arrive earlier than long-distance species, in keeping with trends observed elsewhere. In summary, there did appear to be phenological asynchrony between migrant birds and vegetation within these forests, however more work is needed to connect bioacoustic indices with measured avian and invertebrate diversity.

O48- The acoustic diversity and complexity of the Maromizaha Forest Reserve, Madagascar

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The diversity of acoustic sensory systems and the complexity of acoustic stimuli in the environment shape how animals behave and interact with their surroundings. How the acoustic environment drives behavioral variation that can operate at short time scales can be ideally investigated in Madagascar rainforests. They represent a peculiar situation in which the human impact on managed forest areas led to the identification of different regions of increasing protection enforcement (e.g., touristic, research, and pristine). We focused our research on the ecoacoustics of different areas belonging to the touristic, research, and pristine regions. Our results showed that soundscape patterns changed significantly according to the different protection measures. The Acoustic Diversity Index of the pristine forest areas differed significantly from that of the research and the touristic regions, which instead did not show substantial differences between them. The Entropy H Index and the Acoustic Complexity Index showed that differences were mainly involving the research area versus the other two regions. We conclude that vegetation patterns strongly influence soundscape patterns in montane Malagasy rainforest and that this may result in behavioral adaptations of the critically endangered species living in these areas. In a scenario in which human impact determines an accelerated biodiversity loss, it will be essential to investigate how these indices may vary over time.

O49- At-sea acoustic tracking of seabirds: exploring the soundscapes of highly mobile predators during foraging

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Seabirds are very well-studied in comparison to other groups of animals with equivalent role in the marine environment; however, their behaviour at sea remains difficult to observe and understand, given that these animals are highly mobile, wide-ranging, can spend long periods of time in the open ocean and are often elusive. Recent advancements in the development of biologging technologies have led to the creation of improved, miniaturised sound recording devices that can be deployed directly on animals, enabling scientists to sample their soundscapes in a variety of settings, remotely.
In this study, we combine the use of miniature bird-borne audio recorders with GPS trackers to explore the soundscapes of two albatross species breeding at Bird Island, South Georgia, to investigate their behaviour and environmental context during foraging at sea. Our findings show that at-sea seabird sound recordings allow the precise characterisation of activities they engage in, helping to refine animal movement data, and that events detected through sound recordings are associated with the duration of seabirds foraging activities. We also found that seabird sound recordings permit pinpointing of specific locations at sea where birds congregate. Seabird soundscapes are a repository of useful information waiting to be explored, with potential to unveil new insights into seabird social behaviour and interactions with their environment. By developing our understanding of seabird activities during foraging and mapping the locations where specific behaviours at sea occur, we can inform policy to support seabird protection where and when it is most needed.

O50- Acoustic monitoring of wetland habitats in dry regions (Kuwait): bird community dynamics related to migration

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Wetland bird communities are particularly complex due to a mix between resident and migratory species. The arrival and departure of non-resident species induce important dynamics in terms of species richness and assemblage composition. These dynamics make the monitoring of wetlands rather complex. Wetlands in Kuwait play a very important role for biodiversity as a shelter for many migrant birds, a breeding habitat for residents and a non-breeding habitat for wintering birds, a foraging resource for many species. Artificial and constructed wetlands have helped with restoring several species that avoided coming to Kuwait. With the availability of shelters and food that these new wetlands offer, some species return back to winter or/and breed again.
So far, terrestrial eco-acoustic studies have mainly focused on tropical and temperate habitats but very rarely on open habitats such as wetlands. The main objective of this project is to use the eco-acoustic approach to monitor wetland sites in Kuwait, in order to better understand the local ecological dynamics and to help nature preservation. We plan to describe and monitor the wetland bird community dynamics of Kuwait at several sites. More specifically, we will comprehensively assess the bird population, phenology, turnover, and richness in Kuwait (objective 1), estimate of Alpha diversity using acoustic diversity indices (objective 2), and test the possibility to use acoustics to estimate the phenology of bird migration (objective 3).

O51- Semiochemicals, semiophysicals and their integration for the development of innovative multi-modal systems for agricultural pests' monitoring and control

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Herbivorous insects are primarily thought to depend on olfaction and taste for their intra- and interspecific communication. Thus, semiochemicals (i.e., chemical signals) have been widely studied for pest management applications. However, given that pest behavior does not rely on just one communication modality, stimuli of physical nature, such as light, sounds and vibrations, can also be used to manipulate insect-insect or insect-plant interactions. Moreover, stimuli of different natures can be combined in a multi-modal pest management program to increase the overall efficacy. Besides the widespread use of both chemical and physical signals in multimodal insect communication, the integration of stimuli has hardly been implemented for hardly any crop. This review introduces the term semiophysicals as opposed to semiochemicals and focuses on how pest behavior can be manipulated by discussing three main approaches; i) manipulation of pest orientation through attractive/repellent stimuli, ii) inhibition or promotion of specific pest behaviors and iii) interference with intraspecific communication through disruptive stimuli. For each approach, we provide examples of use of both semiochemicals and semiophysicals. Lastly, we describe the case study of the vineyard agroecosystem in the Trento province, where a multi-pest management program has been successfully developed, and we discuss future perspectives.

O52- Elucidating the acoustic dynamics of Indirana chiravasi with special emphasis on temperature and humidity

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Anuran amphibians use acoustic clues of their surroundings (extrinsic factors) to make their signals meaningful and decodable. Also, their morphology and anatomy (intrinsic factors) play an important role in responding to the environmental clues. Currently, we are investigating the effects of temperature and humidity of surroundings on the acoustic dynamics of Western Ghats endemic species Indirana chiravasi, from its type locality and role of body length, weight, and temperature of individual in responding to changes in surroundings. We realize the response of the species through call rate, average dominant frequency, atmospheric attenuation and speed of sound. The calls of fifty individuals which were recorded manually and analyzed for their temporal and spectral properties in Raven 2.0. We used Partial Least Square Regression (PLSR) approach to understand the interplay between dependent and predictor variables. The significance of the results was determined after Bonferroni sequential correction. Our results bolster known physical phenomenon that the speed of sound increases with increase in temperature ($p < 0.0001$) while the same decreases with increase in humidity ($p < 0.005$). The atmospheric attenuation showed strong positive correlation to average dominant frequency ($p < 0.0001$). Also, the average dominant frequency is strongly negatively correlated with body size (SVL) ($p < 0.005$). The call rate did not show any correlation with variations in temperature and humidity. To check if Temperature-Size rule fits to our model we checked dependency of SVL against Temperature. The SVL showed strong negative correlation ($p < 0.0001$) with temperature which implies the fact that this species follows the temperature-size rule. However, this fact is worrying, as increase in temperature will favor smaller individuals which can produce higher frequencies than larger individuals which ultimately are attenuated more than lower frequencies thus taking a toll on acoustic facilitation of the species. These results become pertinent when we are expecting increase in average global temperature which may become acoustically detrimental to this species.
Key Words: Biodiversity Hotspot, Climate Change, Temperature-Size Rule, Ecoacoustics

O53- SOUND EARTH LEGACY

Andrea Lamount
Sound Earth Legacy

Summary; Sound Earth Legacy is a non-profit organization aiming to preserve the sounds of the earth and supporting pioneer scientific and environmental projects through sound and music. Discover their current projects in the presentation. The organization is open to new collaborations.

O54- Ecotremology - new insights into hidden ecosystems: a pioneer study in meadow habitats

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In 2016, biotremology - study of mechanical communication by surface-borne waves, was defined as an independent scientific discipline. The transmission media (air vs solids) impose different constraints on signal propagation so organisms using different media follow different evolutionary paths.
In our work, we focused on meadow habitats from Slovenia. The vibroscape structure and dynamics were analyzed at different temporal scales, from diel variation to seasonal changes. Substrate vibrations were recorded from plant stems using laser vibrometers. Vibrational events were manually assigned to vibrational signal types (VST) according to their temporal and spectral characteristics. Vibrational signals are species- and sex-specific. Due to the lack of verified publicly available library of vibrational signals, only 13 out of 60 registered VSTs could be identified to species level.
The highest abundance of VSTs was observed at the beginning of July, when the vibrational community included 14 species with three VSTs dominating. The overlap of these signals in time and frequency domain was significantly smaller than it would be by chance. This reveal for the first time a partitioning of the vibroscape, which suggests existence of species interaction for communication channel. Diel variation in vibrational signaling activity was correlated with ambient temperature (Pearson r = 0,7). Wind provided nearly constant background vibrational noise but higher wind velocities (> 0,8m/s) reduced the amount of biological component of vibroscape. Results also revealed differences in vibroscape composition between hairy sedge (*Carex hirta*) and hedge bedstraw (*Galium mollugo*) plants growing on the same meadow. The former included a higher VST richness and higher abundance turnover among individual plants, which may be attributed to plant geometry and host specific plant-animal interaction.
In summary, the vibroscape of a meadow revealed a rich and complex vibratory world which is not directly accessible to humans. Vibrational signaling is the most common form of mechanical communication, particularly common in arthropods, and as such, surface-borne mechanical waves are commonly present in environment and offer readily available and reliable source of information on ecological processes in hidden ecosystems.

O55- Ecoacoustics as a novel tool for assessing pond restoration success: Results of a pilot study

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1. Ecoacoustics is increasingly being used to monitor species populations and to estimate biodiversity in marine ecosystems, but the underwater soundscapes of freshwater environments remain largely unexplored in this respect. Few studies exist concerning the acoustic diversity of ponds, but because aquatic plants and many arthropods such as Coleoptera and Hemiptera are known to produce sound, there is potential to use ecoacoustic techniques to monitor changes in biodiversity and conservation value.
2. This pilot study compares the underwater soundscapes of recently restored open-canopy ponds and unmanaged highly terrestrialized ponds situated in an arable agricultural landscape of North Norfolk, UK, in order to assess the benefits of farmland pond restoration.
3. Daytime sound recordings were made for 10 min in each pond and analysed primarily for arthropod stridulations. In addition, six commonly used acoustic indices were calculated to assess the soundscape biodiversity between the unmanaged and the restored ponds. The stridulations of three diving beetle species (Dytiscidae) were recorded in tank studies to assess the potential for individual species recognition from underwater sound capture.
4. Sound-type richness and abundance, as estimated by visually and aurally identifying arthropod stridulation from spectrograms, were significantly higher in the restored open-canopy ponds compared with the unmanaged terrestrialized ponds. In addition, the acoustic indices 'acoustic complexity' and 'biodiversity index' were significantly higher in restored open-canopy ponds than in unmanaged terrestrialized ponds.
5. The three dytiscid water beetle species recorded in a tank were found to produce distinctive and recognizable sounds, indicating potential to create an audio reference library that could be used for automatic acoustic monitoring of freshwater arthropods.
6. Pond soundscapes are rich in biological information and this study suggests that, with further development, automated passive ecoacoustic monitoring could be an effective non-invasive technique for assessing pond conservation value and pond restoration and management success.

O56- Visualization and Data Science Advances in Soundscape Ecology

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The Science and Technology of soundscape ecology is bound to have a growing impact in the way natural environments are studied, managed and monitored. The amount and complexity of the data collected demand the development of better computational strategies that can evolve to automatic and semi-automatic data processing. At the current stage of data handling in soundscape ecology, the user must be in the center of the discovery process and there is the need for focused effort in developing and adapting data and visual analytics strategies to meet the challenge. Some of the challenges regarding the development of proper tools are:
1. the scale: the same source (recordings) is meant to support a large number of studies, from evaluation of diversity to recovering and estimating presence and abundance of particular species;
2. labelling: for many different applications, accelerating and automating labelling processes is paramount;
and
3. feature analysis: from extracted features to neural network embeddings it is necessary to understand and explain to final users what they are meant to represent.
In this presentation we report on latest results and current developments in tackling these issues for the case of soundscape ecology. We describe tools for landscape and species discrimination by means of both extracted features and neural network embeddings. We reflect on the application of multidimensional visualisation and active learning strategies to support the labelling processes, and we illustrate the application of feature analysis strategies and their role in understanding segregation of soundscapes.

O57- Can we estimate marine biodiversity using sound recordings? Application of acoustic indices at Mozambique Island coral reefs

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Passive acoustic monitoring (PAM) is emerging as an easy, efficient and non-invasive tool to evaluate and monitor the marine environments. Interest in surveying techniques based on acoustic indices is growing among marine ecologists. However, the relation between acoustic indices and biodiversity is not clear for marine habitats. In this study we have tested the potential of three acoustic indices, namely the sound pressure level, the acoustic complexity index, and the temporal entropy, using 24h of acoustic continuous recordings on several sampling points at Mozambique Island coral reefs, to evaluate fish biodiversity. Fish species richness was visually surveyed at each recording place. Sound pressure level was used to segment the recording in percentiles of energy. Indices were averaged for three frequencies bandwidths: 10-1000 Hz, 1000-2000 Hz and full bandwidth up to 22050 Hz. The acoustic complexity index on the frequency bandwidth from 1000-2000 Hz was positively related with fish diversity (R2= 0.4). The average sound pressure level showed also a positive relation with fish diversity, especially if excluding the 0.01 and 0.99 percentiles. Temporal entropy showed no relations with fish diversity. These results suggest that bioacoustics indices can be used as a cost-effective tool to monitor marine environments, but further investigation is needed to interpret the indices values and standardize its use across habitats.

O58- Bats on Waterways inside a City: Bioacustic Research in Brescia (Lombardy, Italy)

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Urban waterways are important habitat for wildlife including bats: along them there may be important roosting sites, as crevices in stone work of old and modern bridges and they are also important foraging areas for these threatened mammals.
In the course of a broader research on distribution and situation of Chiroptera populations, bioacoustic surveys were carried out to record attendance and foraging activity of bats on waterways inside the city of Brescia. In the urban context rivers, streams and drainage ditches represent the only line of ecological permeability and connection between residual elements of naturalness in this territory.
Most of accessible sections of Garza and Garzetta torrents, of Mella river and of Naviglio Grande, N. Cerca and N. Inferiore were surveyed. Some sections, from historical times with a completely underground course, have been monitored at the beginning and end of the underground section. Searches were carried out between months of May and September of 2019, in 25 stations, with 13 bioacoustic detection sessions and 75 locations of 4 hours, for a total of 300 hours of recording, using 6 audio-ultrasonic microphones: 2 Ultramic 384K and 4 Ultramic 384K BLE (Dodotronic Srl, Castel Gandolfo, Italy), with sampling frequency of 384 kHz, on SD memory cards in wav files. Bioacoustic analysis of 1113 recorded bat passes (BP) allowed identification of 7 Chiroptera species, including Myotis daubentonii and Miniopterus schreibersii; Pipistrellus kuhlii (57.32% of the BP), Hypsugo savii (21.02%) and Pipistrellus pipistrellus (16.08%) were most common and ubiquitous species. General average Activity Index detected was 3.71 BP / h, with a maximum of 9.75 BP / h. Simultaneous use of ultrasonic detectors at the ends of investigated underground sections of Garza torrent has proved that bats do not roost there, but that they go on uncovered sections to feed flying invertebrates (Diptera Culicidae, Tipulidae, Chironomidae and Simulidae) in emergency from water or flying towards surrounding public lights.

O59- Listening to climate change: a framework to forecast species spatial and phenological shifts using acoustic monitoring

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Ecoacoustics offers a promising basis to explore the capacity of species to deal with climate change. The use of eco-physiological data has been suggested to develop mechanistic models as a key tool in climate change research, although there is still a vast lack of information. Now passive acoustic monitoring may assist in filling this gap. Recording species calling behaviour over their distribution ranges allow us to estimate the climatic breadth of calling performance and provides a baseline for predictive models. Here, we introduce a general and transferable methodological framework to combine acoustic and biogeographic information aiming at forecasting both phenological and geographical shifts of calling behaviour in response to climate change. We develop two complementary approaches: a boundary model that is based on the recorded climatic breadth of calling and a regression model that fits acoustic activity and climate using generalized linear models. Using a study case based on a continuous acoustic monitoring of populations located at the thermal extremes of the species range, we test these two models, predicting present and future climatic suitability for calling behaviour of Iberian frogs. Both models have high and similar prediction accuracy, and forecast a phenological advance of acoustic activity and a northward and westward shift of suitable climatic conditions for calling behaviour by 2050 under RCP8.5 climatic scenario. Our results suggest that climate change could drive phenological and geographical shifts in the calling activity of the studied species. Our study demonstrates how acoustic monitoring techniques represent a valuable opportunity for the field of climate change research.

O60- Biogeography of fish sounds: Acoustic communities are tuned by the habitat

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Monitoring marine biodiversity and understanding their drivers across geographic scales is essential to preserve ecosystems functions and associated services. Monitoring marine habitats, their responses to environmental pressures or management actions is often challenging, in particular at large scales. Ecoacoustics is a promising avenue, yet the drivers of acoustic community composition remain unknown, as well as to which extent acoustic biodiversity can reflect environmental status and the effectiveness of protection measures. Here we unveil the biogeography of fish sounds of 27 coralligenous reefs across the North-Western Mediterranean, covering 2000km and three regions. We also applied community ecology principles to the fish sounds of a marine protected area (MPA) with different protection levels to evaluate how habitat and protection levels shape acoustic fish communities. We found 28 putative coralligenous fish sound types, which is twice as much as recorded in other Mediterranean habitats making coralligenous reefs an acoustic hotspot. 40% of these sounds are not found in other coastal habitats, thus likely specific to coralligenous reefs. Acoustic diversity differed between geographical regions. Ubiquitous sound types were identified, among these, sounds from top-predator species, and others more specifically related to the presence of ecosystem engineers (red coral, gorgonians), which are key players in maintaining habitat function. Depth, percent of coralligenous outcrops and habitat condition were the main determinants of acoustic community composition indicating that acoustic fish communities are related to benthic assemblages. We also found that acoustic community composition and diversity were mainly driven by the MPA's protection levels. Fully protected sites were more diverse and hosted more sounds from a few high-level predators than partially protected sites. This work reveals that acoustic biodiversity can contribute to habitat biogeography, depict habitat conditions, be indicative of protection levels, and infer information on ecosystem functioning. This is highly relevant for conservation and habitat monitoring.

O61- Ecoacoustics in Support of Quiet Area Ecological Connectivity Plans

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Ecological connectivity is highly associated with conservation and could be described as the degree to which the landscape and hence the soundscape, facilitates or impedes the movement of species among resource patches at structural and functional level. Urban green areas and quiet areas offer a series of ecosystem services with a range of environmental, social and cultural opportunities for city dwellers. The specific areas could be perceived not as independent units, but as disconnected components of a landscape that require reconnection, within the urban environment. Apart from the structural characteristics of an urban landscape, environmental noise could pose as a non-physical barrier that impedes ecological connectivity at a functional level. The overall purpose of this research is to support the ecological connectivity scheme of two quiet areas in Mytilene (Lesvos Island, Greece). By means of sound recordings, several acoustic biodiversity indices, provided by the multidisciplinary field of ecoacoustics, were extracted. The noise maps created using noise prediction software highlighted the effects of noise amongst the two quiet areas. Furthermore, the visualization of the Acoustic Complexity Index inside and in between the two quiet areas highlighted the differentiation of the diversity levels and therefore the spots that are highly affected by noise at both, functional and structural level.

O62- Soundscape and bird community at the Braulio Carrillo National Park, Costa Rica, related to highway 32

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Natural areas are being increasingly disturbed by vehicular traffic on roads. In Costa Rica, 41.2% of protected areas are directly or indirectly influenced by roads. Many studies have associated road disturbances with noise, but the possible causes are multiple and often times intercorrelated. We characterized the soundscape and bird community in two study sites at the Braulio Carrillo National Park (BCNP) of Costa Rica, selected according to the distance to highway 32, a national road of high vehicular traffic that crosses the BCNP: "Quebrada" (contiguous to the road), and "Ceibo" (20 km away from the road). We conducted four visits to each site from June 2017 to August 2018. We sampled the soundscape (using sound recordings), bird community (using point counts) and vegetation structure complexity (using vegetation plots and photos) in 12 sampling points in each area. We obtained 11 acoustic indices and 4 bird indices derived from point counts. Ceibo bird community was mainly composed by forest birds, while in Quebrada we also found birds from open areas. Quebrada presented a more open forest structure and lower density of trees and shrubs; lower evenness and higher acoustic complexity, higher bioacoustic activity and sound pressure level; higher bird abundance and richness. Ceibo showed a higher density of trees and shrubs, higher complexity of vegetation structure, higher proportion of biophonies than anthrophonies, and an acoustic community with higher diversity and entropy. Acoustic community seemed to be more diverse and better partitioned in the least disturbed site Ceibo; while less even in the most altered site Quebrada, where niches were created for open areas birds by the road effect on vegetation structure and the presence of the adjacent "Rio Sucio" river canyon. Soundscapes seemed to properly reflect the habitat condition, and are promising for evaluating the ecological condition of a site.

O63- Tuning acoustic communities: phylogenetic, functional and acoustic beta diversity

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How biophonies vary across ecological communities has been a central topic in Ecoacoustics. In each region, acoustic diversity is determined by local (alpha) and between-sites (beta) variation in sounds. While alpha diversity has been widely investigated, little is known about beta acoustic diversity. Anuran amphibians offer ideal models to tackle acoustic space-related questions and its relationship with acoustic diversity. As such, an increase in species richness is generally followed by increased local acoustic diversity. However, we still lack an understanding of how acoustic spaces vary between communities. Here, we investigated the acoustic features and composition of anuran communities in the Atlantic Forest by sampling ten different ponds in southeastern Brazil, between September 2018 and March 2019. Acoustic space can be characterized in different ways, mostly through the use of remote recorders. In this work, we explored an alternative approach based on directional recordings that estimate the occupation of frequency bins (10 classes between 650Hz and 6500Hz) for two acoustic parameters of advertisement calls: i) dominant frequency and ii) frequency ranges. We then calculated an overall beta diversity index based on the Sørensen-based multiple-site dissimilarity and assessed its turnover and nestedness components. We found a large variation in species composition and acoustic composition of communities based on dominant frequency, mainly determined by the turnover component. By evaluating communities' pairwise similarities, we observed that similarities in dominant frequency across communities were correlated with compositional similarities, different from what was observed for the frequency range. Such findings indicate that acoustic spaces derived from "high resolution", as dominant frequency, seem to be more efficient represent actual patterns of biological variation across communities. Still, it remains to explain the variation in cross-communities acoustic composition that are unrelated to compositional differences.

O64- What is a Soundscape ? : New perspectives based on a functional representation

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The concept of soundscape was coined to describe a given acoustic environment and to highlight the complex ecosystemic mechanisms that explain its structure. Several definitions of soundscapes have been proposed based on musical, acoustical and ecological perspectives. However, the cause-effect mechanisms that underlie soundscapes are often overlooked. In addition, the term "soundscape" is often used in an ambiguous way, pointing to both objective and subjective realities. Through a transdisciplinary review, we tried to identify and understand the relationships between the main biotic and abiotic factors that condition non-anthropogenic terrestrial soundscapes. We used a source-filter approach to describe sound sources, sound propagation phenomena and receiver's characteristics. We crossed-referenced inter-disciplinary information in order to identify links between factors, sound sources and filters. We organized those relationships and the associated references in a functional diagram. Finally, we used this representation to question the different uses and meanings of the "soundscape" concept found in the literature. We then defined three separate operational notions : soundscapes, acoustic scenes and interpretations. This study brings a new systematic approach to soundscapes that can help ecoacousticians, bioacousticians, psychoacousticians and environmental managers to better understand soundscapes and protect natural areas in a more significant way.

P65- An ecoacoustic study of urban forest landscape of National Capital Region of Delhi

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Ecoacoustic approach to characterize different soundscapes and its biological and non-biological components have become a widely accepted tool for monitoring habitats and its biodiversity in a particular environment. In present study, we selected five different forest sites in the National Capital Region of Delhi. We chose three different locations at each site, one at the edge of a road and others two within interior of the forest to also examine the effect of anthropogenic noise. We recorded 24h continuous ambient soundscape at these locations for consecutive five days using SWIFT autonomous recorders between April to June of 2019. We used AnalysisPrograms.exe developed by Ecoacoustics Research Group, University of Queensland to generate 24h false-colour spectrograms for visualization and to calculate different acoustic indices (AIs) for analysis. We investigated 1) how do the AIs vary across different forest sites and 2) how do they differ at locations with different anthropogenic noise conditions within each site. We examined particularly two indices namely Acoustic Complexity Index (ACI) and Normalized Difference Soundscape Index (NDSI). Our result showed that both the indices were significantly different at different forest sites showing high values for the site with high degree of native condition and minimal anthropogenic disturbance. However, within each forest site ACI values did not differ much at the three different locations but NDSI values were significantly able to reflect the varied presence of anthropogenic noise at the locations and were lower at locations close to road compared to the interior ones. The results shows the applicability of acoustic indices to characterize different habitats under different anthropogenic influences which can further be used for long term monitoring and conservation purposes.

O66- Tropical acoustic diversity: monitoring of a seed disperser, the White throated toucan

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Seed dispersers play a key role in the structure and dynamics of tropical forests. At the time of the Anthropocene with direct (defaunation) and indirect (habitat degradation, climate changes) impacts on wildlife, monitoring seed disperser populations is crucial for tropical conservation. Using ecoacoustics methods, we tracked in a lowland forest of French Guiana the populations of a major seed disperser, *Ramphastos tucanus* the White throated toucan, in a context of human pressure (hunting, logging, agriculture). We deployed an acoustic survey based on nine automatic recorders over 29 days at the beginning of the rainy season. We gathered weather data and described with GIS tools the habitat used by *R. tucanus* around each recorder. The vocalizations of *R. tucanus* were automatically identified in 22,490 recordings through a template matching method that had an area under the curve (AUC) of the Receiver Operating Characteristic curve (ROC) of 0.9184. The variation of vocal activity at spatial and temporal scale was assessed with a generalized mixed model. The automatic system detected a total of 1,748 recordings with toucans' vocalizations. The rainfall could have a positive delayed effect on vocal activity so that *R. tucanus* seems to be more active before heavy rains. There is a diel pattern of *R. tucanus* vocalization with two peaks at 6 am and 6 pm. There was no major effect of habitat on vocal activity due to a few differences between recording sites. There was a higher vocal activity in the highest logged site compared to the agricultural one. Acoustics was a reliable strategy to monitor toucans as it revealed a clear temporal pattern and indicated a human footprint impact. This later impact could be related not only to the toucans but to the interaction within a community of seed dispersers.

O67- Acoustic indices perform better when applied at ecologically meaningful time and frequency scales

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Acoustic indices are increasingly employed in the analysis of soundscapes to ascertain biodiversity value. However, conflicting results and lack of consensus on best practices for their usage has hindered their application in conservation and land-use management contexts. Here we investigate whether the sensitivity of acoustic indices to ecological change and fidelity of acoustic indices to ecological communities are negatively impacted by signal masking. Signal masking can occur when acoustic responses of taxa sensitive to the effect of interest are masked by less-sensitive acoustic groups, or target taxa sonification is masked by non-target noise. By calculating acoustic indices at ecologically relevant time and frequency bins, masking effects can be reduced and the efficacy of indices increased.
We test this on a large acoustic dataset collected in Eastern Amazonia spanning a disturbance gradient of undisturbed, logged, burned, logged-and-burned and secondary forests. We calculated values for two acoustic indices: the Acoustic Complexity Index and the Bioacoustic Index, across the entire frequency spectrum (0–22.1 kHz), and four narrower subsets of the frequency spectrum; at dawn, day, dusk and night. We show that signal masking impacts the sensitivity of acoustic indices and calculating acoustic indices at a range of narrower time–frequency bins substantially increases the classification accuracy of forest classes with random forest models. Furthermore, we found signal masking led to misleading correlations, including spurious inverse correlations, between biodiversity indicator metrics and acoustic index values compared to correlations derived from manual sampling of the audio data.