QUT

QUT Ecoacoustics Symposium

Open Ecoacoustics

www.openecoacoustics.org

Ecoacoustics 2022

Transforming Conservation Through Sharing of Ecoacoustics Science and Practice

2-4 November 2022, QUT Gardens Pt Campus, Brisbane, Australia

Symposium Organisers: Susan Fuller, Paul Roe, Daniella Teixeira and Kellie Vella, QUT

For any enquiries, please contact: ecoacoustics2022@qut.edu.au

Organised by QUT, a founding member of the Australasian Chapter of Ecoacoustics

The Australasian Chapter of Ecoacoustics (ACEs) is a branch of the International Society of Ecoacoustics. ACEs is comprised of members from all across Australia and New Zealand who use Ecoacoustics for research, natural resource management or as a general interest. The group has been developed to share knowledge, network and collaborate on all things Ecoacoustics.

Rationale & Goal

Australia's biodiversity crisis necessitates urgent action to deliver broad-scale monitoring and management of threatened species and ecosystems. Acoustic monitoring is set to revolutionise this by capturing a permanent, direct, scalable and objective record of the environment. But, managing and analysing big acoustic data is difficult; data, analyses, analysis tools, effort and expertise need to be shared. Furthermore, we have no standard protocols and methods for acoustic monitoring.

This is the fourth in a series of successful ecoacoustics meetings at QUT (2017, 2018, 2020). This symposium will cover science through to practice, and aims to:

- Bring together researchers and practitioners who use ecoacoustics in conservation to share knowledge;
- Provide training in ecoacoustics data analysis tools and techniques;
- Promote open science and sharing of data and analyses tools;
- Network, collaborate and advance the research field of ecoacoustics.

The primary focus of this symposium is on ecoacoustic applications in conservation and monitoring of audible terrestrial fauna.

Program at a glance

Wednesday 2 November

- Morning: Welcome, Keynote and Oral Presentations
- Afternoon: Workshops (Ecoacoustics basics or Practitioner's); Meet the Experts panel
- Dinner

Thursday 3 November

- Morning: Keynote and Oral Presentations
- Afternoon: Birds of Feather (themed informal discussions), Open Ecoacoustics Demo, Round table (Do we need an Australian Ecoacoustics Network?)
- Poster Session, Reception and Networking

Friday 4 November

- All day workshop – Make Your Own Recogniser (limited numbers – participants with accepted EOI only)

Venue

All sessions will take place at QUT Gardens Point Campus.

Wednesday 2 November – The morning session will take place in B Block, Room 117. A lunchtime sponsor workshop will occur in D101. The afternoon workshops will take place in S Block Rooms 636/637. The 'Meet the Experts' panel will occur at 4pm in B Block, Room 117. Dinner will be off campus and is not included in the registration fee. Lunch, morning and afternoon tea will be provided in the D Block concourse open area.

Thursday 3 November – The morning session will take place in Z Block, Room 401. Lunch will be provided in the Z block, level 4 Atrium. A lunchtime sponsor workshop will occur in Z401. The afternoon session will take place in S Block Rooms 636/637, followed by a poster session at the P Block, Level 4 Cube at 3.30pm, and drinks and networking from 4pm at the P Block concourse, Level 4. Lunch and morning tea will be provided in the Z Block, Level 4 Atrium.

Friday 4 November – The workshop will be held in P Block, Rooms 413A. Lunch will be provided in P413 (adjoining room).

Proudly supported by:

WI-FI INFORMATION

If you require Wi-Fi access, please use the **'QUT Public WiFi'** network. To use it you will need to create an account and verify it using your email address or phone number.

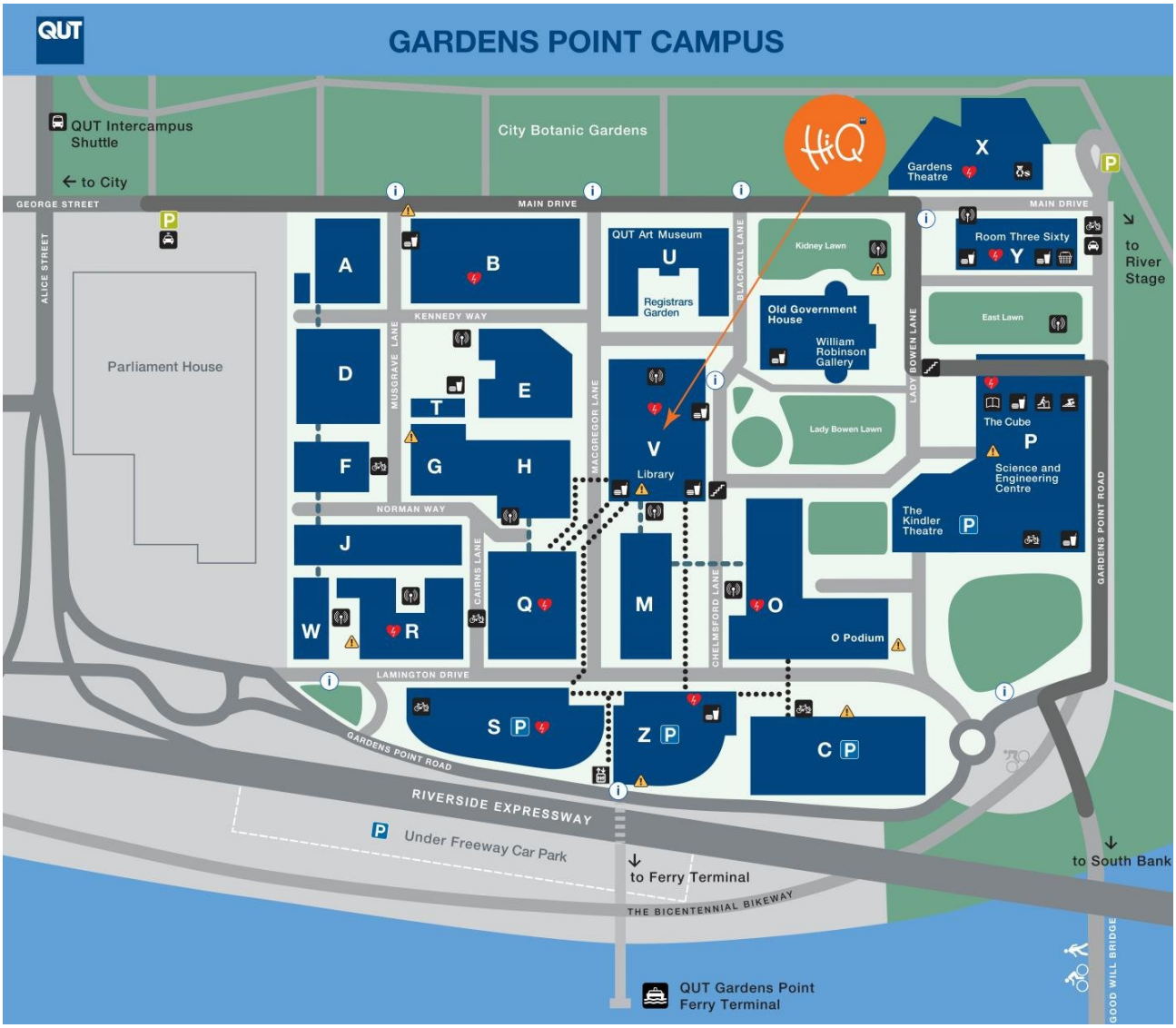
To create an account, you need to:

1. Go to the login page**: https://qut.vostro.live/register/**
2. Read and agree to the the Terms of Service and Privacy Policy.
3. Select 'Register for Wi-Fi access'.
4. Fill out your details and create a password.
5. Select 'Register'.
6. You will be sent a verification email or a text message to verify. Select the link in the message to verify.

To access the Wi-Fi, you need to:

1. Select the 'QUT Public Wi-Fi' network on your device.
2. In the pop-up login page, read and agree to the Terms of Service and Privacy Policy.
3. Log in with your email and password.

CAMPUS MAP


QUT
GARDENS POINT CAMPUS
QUT Intercampus Shuttle
← to City
City Botanic Gardens
HiQ
Gardens Theatre
X
GEORGE STREET
MAIN DRIVE
MAIN DRIVE
↘ to River Stage
ALICE STREET
Parliament House
A
B
QUT Art Museum
U
Registrars Garden
BLACKALL LANE
Kidney Lawn
Old Government House
William Robinson Gallery
Room Three Sixty
Y
East Lawn
KENNEDY WAY
MUSGRAVE LANE
D
T
E
MACGREGOR LANE
V
Library
LADY BOWEN LANE
Lady Bowen Lawn
The Cube
P
Science and Engineering Centre
F
G
H
NORMAN WAY
The Kindler Theatre
GARDENS POINT ROAD
J
CAIRNS LANE
Q
M
CHELMSFORD LANE
O
O Podium
W
R
LAMINGTON DRIVE
S
Z
C
GARDENS POINT ROAD
RIVERSIDE EXPRESSWAY
Under Freeway Car Park
↓ to Ferry Terminal
↓ to South Bank
THE BICENTENNIAL BIKEWAY
GOOD WILL BRIDGE
QUT Gardens Point Ferry Terminal

PROGRAM – WEDNESDAY 2 November 2022

Morning Session - B Block, Level 1, Room 117

8.00 to 8.45am Registration and Coffee

8.45 to 9.05am Welcome to Country

9:05 to 9:15am Introduction by the Symposium organisers

9.15 to 9.30am Official opening by Professor Hugh Possingham, University of Queensland

Session 1 – chaired by Dr Daniella Teixeira

9.30 to 9.50am Keynote Presentation – "Unlocking the secrets of bird migration in Australia" by Prof Rich Fuller, University of Queensland

9.50 to 10.40am Oral Presentations

- Geoff Smith "Post the wallum-heath wildfires of 2019-20 in SEQ: what did acoustic detection show about eastern ground parrots?"
- Saskia Gerhardy "Acoustic monitoring for drought response: Plains-wanderer (*Pedionomus torquatus*) detections in the South Australian semi arid rangelands"
- Lin Schwarzkopf "Our journey to extracting species lists from long-term recordings by the Australian Acoustic Observatory"
- Aaron Grinter "Improved conservation outcomes for the critically endangered Plains-wanderer through bioacoustic analysis of landscape-scale population dynamics"

10.40 to 11.00am Morning Tea (D Block concourse open area)

Session 2 – chaired by Dr Kellie Vella

11.00 to 11.20am Keynote Presentation "Building a continuum of community engagement in ecoacoustic monitoring" by **Dr Karen Rowe**, Museum of Victoria

11.20 to 12.10pm Oral Presentations

- Daniella Teixeira "Acoustic occupancy monitoring of threatened glossy black-cockatoos in bushfire-affected south-east Queensland"
- Berndt van Rensburg "Assessing acoustic competition between sibling frog species using rhythm analysis"
- Rob Clemens "The potential for ecoacoustic data to transform our understanding of species distributions"
- Susan Campbell "Application of remote acoustic detection technology enhances wildlife management"

12.10pm to 1.00pm Lunch (D Block concourse open area)

Lunchtime sponsor workshop – Frontier Labs – D block, room 101

PROGRAM – WEDNESDAY 2 November 2022

Afternoon Session - S Block, Level 6, Rooms 636/637

1.00pm to 3.30pm

Workshop A (Room 636) - Ecoacoustics Basics – Dr Michael Towsey, Callan Alexander, Marina Scarpelli and Dr Anthony Truskinger

This workshop is designed for students and those new to ecoacoustics methods. This 2-hour workshop will cover the nature of sound, sound recording and recorders, sound representation (files, formats and manipulation), playing sound and basic effects and analyses (filtering, plotting, and more), freely available tools, calculating and interpreting acoustic indices, and false-colour spectrograms. The workshop is broken up into five hands on sessions 1) Sound basics; 2) Sound recording; 3) sound labelling; 4) Acoustic indices; 5) Sound file wrangling

OR

Workshop B (Room 637) – Best practice monitoring of Australian terrestrial vertebrates using ecoacoustic field surveys – facilitated by A/Prof Susan Fuller and Dr Daniella Teixeira

The objective of this workshop is to create a best practice guideline for terrestrial ecoacoustic surveys in Australia. A diverse range of practitioners from non-profit, government and academic sectors will be invited to contribute their experiences. This will ensure that outputs are relevant to real-world monitoring. The intention is to publish the workshop's findings as a peer-reviewed paper, but also to work with relevant stakeholders (government and non-profit organisations) to help encourage the adoption of best practice methods.

3.30pm to 4.00pm Afternoon Tea (D Block concourse open area)

Meet the Experts Panel – B Block, Level 1, Room 117

4.00pm to 5.00pm Join **Prof Almo Farina, Prof Jerome Sueur, Dr Alice Eldridge and Dr Amandine Gasc** for this informal and interactive discussion on

1) what motivated them to become involved in Ecoacoustics research,

2) what their current research interests are and the big questions they want to investigate and

3) what challenges exist and future innovations and research direction are needed to address them.

Facilitated by A/Prof Susan Fuller




5:45pm Dinner at the Ship Inn, Southbank

Please note: dinner is 'buy your own' and is not included in registration fee

PROGRAM – THURSDAY 3 November 2022

Morning Session - Z Block, Level 4, Room 401

8.30 to 9.00am Coffee and registration (Z block, level 4 Atrium)

Session 3 – chaired by Assoc Prof Susan Fuller

9.00 to 9.20am Keynote Presentation – "Acoustics for Conservation" by **Dr Michael Towsey & Dr Liz Znidersic,** Charles Sturt University

9.20 to 10.10am Oral Presentations

- Sheryn Brodie "Bridging bioacoustics and ecoacoustics: revealing ecological patterns in a chorusing frog community"
- Dominique Potvin "Effects of ecotourist noise on an avian community: a case study from a UNESCO world heritage site"
- Elisa Girola "Long-term acoustic monitoring of Australian ecosystems"
- Simon Linke "Biosecurity: Early detection and community change monitoring using passive acoustics"
- Mohammad Abdur Razzaque Sarker "Chorusing behaviour of frog communities in response to environmental flow in Gwydir River catchment, Australia"

10.10 to 10.40am Morning Tea (Z Block, Level 4, Atrium)

Session 4 –chaired by Prof Paul Roe

10.40 to 11.00am Keynote Presentation "A Tutorial for DIY Ecoacoustic International Programs" by **Dr Amandine Gasc**, IRD, France (online)

11.00 to 12.00pm Oral Presentations

- Leroy Gonsalvez "Considerations for landscape monitoring of forest fauna using acoustics"
- Peter Griffioen "Progressing deep learning species call recognition from a research topic to an everyday tool"
- Brad Law "Using acoustic arrays to cost-effectively estimate density"
- David Watson & Liz Znidersic "Acoustic restoration: Using soundscapes to benchmark and fast-track recovery of ecological communities"
- Paul McDonald "Linking acoustic indices with avian biodiversity on the New England Tablelands: a cautionary tale from a multi-year dataset"

12.00pm to 1.00pm Lunch (Z Block, Level 4 Atrium)

Lunchtime workshop – Wildlife Acoustics (Z block, Level 4, Room 401)

PROGRAM – THURSDAY 3 November 2022

Afternoon Session - S Block, Level 6, Rooms 636/637

1.00pm to 2.00pm Birds of a Feather – Participant-generated informal discussions based on mutual interests. Facilitated by Prof Paul Roe

We will begin the session by asking participants to nominate a topic of interest for discussion/research area or collaboration that they would like to develop. Topic proposers move to different tables and the rest of the participants move around the room to converse. This is a free-form session -we particularly encourage early-career researchers to take advantage of this opportunity to engage with the vast range of experts attending the symposium.

2:00pm to 2:30 Open Ecoacoustics demo - Presentation and demonstration of the open ecoacoustics project (www.openecoacoustics.org), including training materials, recogniser repository, client tools and cloud system.

2.30pm to 3.30pm Roundtable Discussion - Facilitated by A/Prof Susan Fuller & Dr Daniella Teixeira

Do we need an Australian Ecoacoustics Network? Acoustic monitoring is revolutionising how we survey biodiversity; providing a permanent, direct, and objective record of the environment. Ecoacoustics offers a solution for scalable ecosystem monitoring and initiatives such as the A2O will contribute towards a national ecosystem observatory capability (2016 Roadmap). From a research perspective, Ecoacoustics is now recognised and respected as a scientific field of inquiry. But, how do we put Ecoacoustics on the National agenda?

3.30pm to 5.00pm Poster Session & Reception - Drinks & Networking (P Block, Cube and use P4 Concourse for drinks setup)

- Yasara de Mel "Using acoustic data to resolve species boundaries in lyrebirds, the masters of mimicry"
- Callan Alexander "Passive acoustic monitoring and deep learning to detect different age-classes of a cryptic threatened owl (*Ninox strenua*)"
- Marina Scarpelli "Continental scale biodiversity assessment through combined acoustic and satellite remote sensing"
- Stephen Molan "Measuring frog communities with acoustic sensing across a sub-tropical urban matrix"
- Lana Prior "Vocalisation patterns of the Eastern Ground Parrot (*Pezoporus wallicus wallicus*) and implications for acoustic monitoring efforts"
- Thomas Napier "Species Classification Using Deep Learning Signal Processing Techniques in Large-Scale Natural Soundscapes"
- Andrew Schwenke "Advertisement call variation in *L. wilcoxii* and *L. jungguy*"
- Lance de Vine "Automated acoustic detection of threatened birds with complex vocal repertoires"
- Benjamin Rowe "Extracting features from environmental audio with frequency preserving autoencoders"

PROGRAM – Friday 4 November 2022

Make Your Own Recogniser Workshop – P Block, Level 4, Room 413/413A

Please Note: participant numbers are limited, submission and acceptance of EOI required

8.30 to 9.00am	Coffee (P413)
9.00am to 12.00pm	Train Your Recogniser (P413A)
12.00pm to 1.00pm	Lunch (P413)
1.00pm to 3.00pm	Test and Validate Your Recogniser (P413A)

KEYNOTE BIOGRAPHIES AND ABSTRACTS

Prof Richard Fuller

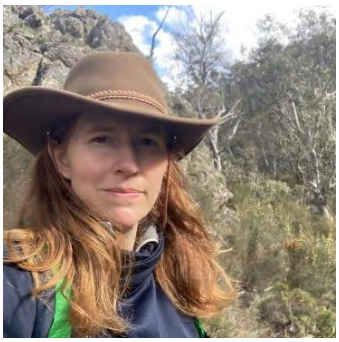
Professor Richard Fuller (University of Queensland) studies how people have affected the natural world around them, and how some of their destructive effects can best be reversed. To answer these questions, the lab group works on pure and applied topics in biodiversity and conservation, spanning the fields of migration ecology, conservation planning and urban ecology. Much of the work is interdisciplinary, focusing on the interactions between people and nature, how these can be enhanced, and how these relationships can be shaped to converge on coherent solutions to the biodiversity crisis. See www.fullerlab.org and www.facebook.com/fullerlab

Unlocking the secrets of bird migration in Australia

Richard Fuller, School of Biological Sciences, University of Queensland

Many Australian birds migrate, but the timing and patterns of their journeys are poorly understood. Lowland Indonesia and Papua New Guinea are visited by Australian species during the non-breeding season, but what proportion of our birds leave the country on migration remains unknown, hampering international conservation efforts. Unfortunately migration is hard to study. Rather few Australian species have been satellite-tracked, and the sheer size of the country means few banded birds are recaptured elsewhere along their migration route. Complicating matters further, many species migrate at night, making visual observations impossible. To start to fill some of these gaps, we have been using passive acoustic recorders to listen for nocturnal birds migrating over the suburbs of Brisbane. It turns out that while the city sleeps, migratory birds are streaming overhead, with the calls of kingfishers, rails, cuckoos, shorebirds, bee-eaters and others punctuating the night. Hundreds of migrating birds can fly over my backyard in a single night during the peak migration season. While passive acoustic monitoring has clear potential for studying migration, there are plenty of challenges to sort out. These include solving the dozens of mystery calls that have even Australia's greatest birdwatchers baffled, scaling up the work to multiple locations across the country, and triangulating acoustic data with other information, such as weather radar data and citizen science observations. I conclude that acoustic monitoring could underpin a breakthrough in studying bird migration in Australia if we can address these pressing challenges.

Dr Karen Rowe



Dr Karen Rowe is the Curator of Birds at Museums Victoria where her research focuses on developing and implementing acoustic survey methods to document the diversity of distribution of animals across landscapes. Projects in Karen's lab combines acoustics with biodiversity inventories, threatened species monitoring and community engagement. Her work actively focuses on using acoustic technologies to bring together land managers, landcare groups and community participants towards improved management and conservation outcomes for wildlife. Current projects include documenting the impact of the Black Summer bushfires on bird communities in East Gippsland and tracking the spatio-temporal calling dynamics of Victoria's critically endangered Plains-wanderer.

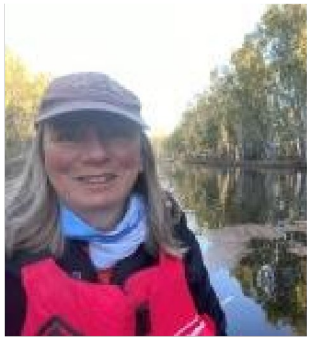
Building a continuum of community engagement in ecoacoustic monitoring

Rowe, K.M.C. [1,2], Blair, S.[3] and Grinter, A.[4]
[1] Museums Victoria, Sciences Department, Carlton, Victoria, Australia.
[2] University of Melbourne, School of BioSciences, Parkville, Victoria, Australia.
[3] Victorian National Parks Association, Carlton, Victoria, Australia.
[4] Department of Environment, Land, Water and Planning, Epsom, Victoria, Australia.

Strategic public engagement in nature is increasingly prioritised at both the state and national level, to achieve nature connection, caring for country, and the sharing and building of knowledge (e.g., Australia's Strategy for Nature 2019 – 2030). At the same time, effective conservation policy and management requires the continued collection of distributed, standardised biodiversity data to track threatened species trajectories, document wildlife population dynamics and assess the overall health of ecosystems. Public engagement in ecoacoustic surveys and monitoring projects can combine the two, by providing unique and varied opportunities for citizen scientists to participate in scientific research for improved policy and management outcomes.
Ecoacoustic biodiversity monitoring programs offer communities an opportunity to engage in project conception, sampling design, data collection, acoustic analysis and report preparation. But the success of such programs relies on the alignment of public interest, communication between researchers, managers, and participants, skill sets, and intended outcomes. We explore the components of successful community ecoacoustic projects using two case studies, the Victorian Plains-wanderer song meter program and Communities Listening for Nature. While differing in their approach and depth of engagement, both programs use an ecoacoustics approach to document species and soundscapes. Common components associated with the success of each program include hands-on training, tailored involvement of participants based on skills and interest, low-cost and fit-for-use tools (e.g., acoustic analysis software and online interfaces), direct and regular communication between researchers and participants, and end-of-project reports and presentations. We summarise our learnings and outcomes by proposing a continuum of community engagement opportunities, empowering researchers and practitioners to apply ecoacoustic approaches as part of a community engagement biodiversity monitoring strategy.

Dr Michael Towsey & Dr Liz Znidersic

Dr Michael Towsey has held research positions at Queensland University of Technology (QUT) since 1997 and more recently at Charles Sturt University. Since 2008, he has been working in the field of soundscape ecology and on the conservation of threatened cryptic species such as the Lewin's Rail, Australasian Bittern and Little Bittern. Michael developed a technique to visualise long-duration recordings of the natural environment using false-colour spectrograms. When combined with automated call-recognition software, these techniques promise a solution to the data deluge problem confronting eco-acousticians. See https://eavesdroppingonwetlandbirds.com.au

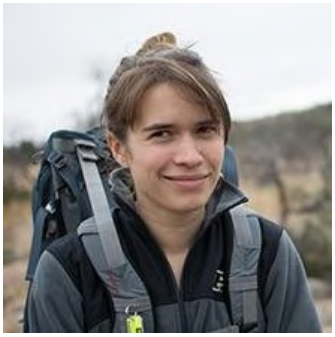


Dr Elizabeth (Liz) Znidersic is a post-doctoral researcher at Charles Sturt University. Her major research interests include survey methodologies and the application of technological tools to monitor individual species and ecosystems, wetland species and their management. She is currently working on the "Eavesdropping on wetland birds" project investigating wetland species from Queensland to Tasmania which makes use of both call-recognisers and soundscapes. Liz's research has led her into the wetlands of the USA and Australia, and remote islands of the world searching for some of the most secretive wetland birds using acoustic recordings and motion-activated cameras. She has also worked extensively as a ranger and environmental educator with nature-based tourism. See https://eavesdroppingonwetlandbirds.com.au

Acoustics for conservation
Towsey, M. & Znidersic, L.

Monitoring methods must be adapted to best fit the species and the environments they inhabit. Increasingly, technological approaches such as acoustics are critical when surveying for threatened species where minimal data is available to support management decisions. Here we demonstrate a cross-discipline example of how ecological insight can be supported and enhanced by computer science. To gain a perspective in monitoring of a threatened Australian wetland bird, the Australasian Bittern, we supplement traditional monitoring methods with acoustics. We will demonstrate how acoustic indices calculated at one-minute resolution can be used to detect the calls of the bittern. This is further expanded in to how can on-ground managers can apply current and new monitoring tools to refine either recording time or time the field. In addition, the same acoustic indices can be used for content recognition purposes which is useful for filtering long duration recordings to find content of interest.

Dr Amandine Gasc



Dr Amandine Gasc background is in ecology and biological conservation with a specialty in acoustics. Thanks to a CNRS INEE PhD Grant, her PhD research at the National Museum of Natural History in France focussed on the analysis and monitoring of animal biodiversity using acoustics. She then undertook post-doctoral research funded by the NSF in the Center for Global Soundscapes at Purdue University. Her research investigated how soundscapes can be used to detect environmental changes and the impacts of these changes on animal communities. Amandine is now a researcher at the Institute for Research and Development in France working in the Mediterranean Biodiversity Unit for Continental and Marine Ecology. Her objective is to develop efficient, accurate and well tested acoustic analysis approaches that can provide a better understanding of natural ecosystems, biodiversity and their response to external perturbations such as invasive species, human activities and fire.

Tutorial for DIY Ecoacoustic international programs
Dr. Amandine Gasc

Are you thinking of launching a large ecoacoustic collaborative program? Without money? In four days? I will tell you the story of a team of five who jumped into this unrealistic idea and what they learnt from it. During the Covid-19 pandemic, the Silent Cities Project was launched as an international initiative to collect soundscapes of locked-down cities worldwide. This example will serve as a baseline to discuss opportunities and challenges of big data management, from the mobilization of the ecoacoustic community to the collection and management of big data recording collections. Solutions inspired from other large ecoacoustic programs will enrich the discussion.

ORAL PRESENTATION ABSTRACTS

(in chronological order)

Post the wallum-heath wildfires of 2019-20 in SEQ: what did acoustic detection show about eastern ground parrots?

Geoffrey C. Smith[1], Michael T. Mathieson [1], George Krieger[2], Luke D. Hogan [1], Emily Snell[3], William Goulding[4] and Clare Hourigan[3]

[1] Queensland Herbarium, Brisbane Botanic Gardens, Mt Coot-tha Rd, Toowong, QLD

[2] Queensland Parks and Wildlife Service, The Gap, QLD

[3] c/o Threatened Species Operations, Queensland Parks and Wildlife Service, Moggill, QLD

[4] Queensland Museum, Southbank, Brisbane, QLD

In 2019-20 wildfire burnt across Cooloola, Noosa and the Sunshine coast, a large area of coastal wallum-heath vegetation in SEQ, potentially impacting ground parrot *Pezoporus wallicus wallicus* populations in these areas. Listening surveys (19 sites 2020 only) and automated Bioacoustic Recorders (BAR^{TM}, Frontier Labs) were utilised to assess ground parrots in burnt and unburnt habitat. BARs were deployed over the 2020 and 2021 breeding periods (July to September) at 13 and19 sites respectively, across the landscape. Sound files recorded by BARs were analysed manually using Raven^{TM} Software to assist recognition of calls. BARs allowed capture of information about patterns of variability in calling behaviours through time and space across the landscape that has hitherto been constrained by logistic issues for individual human observers. Variability in calling patterns through time has important consequences for effective sampling of ground parrot presence-absence and abundance estimates. Utilising knowledge about calling behaviour we ascertained population level data on the effects of the wildfires on the ground parrot population in the Cooloola Section of the Great Sandy National Park. This is an extremely important area for ground parrot in the Australian context. At the landscape level, a large section of the habitat potentially occupied by ground parrots was not affected by the wildfire. Where ground parrot habitat was burnt, there was evidence of possible low-medium level impact but no perceived major impact. A population estimate for the Cooloola-Noosa North Shore region suggests that the population has remained stable for the past 30 years. A fire management strategy is operational within the landscape and is considered necessary to reduce the threat of wildfire decimating ground parrot habitat on a wide scale and to maintain habitat structure and seed availability

Acoustic monitoring for drought response: Plains-wanderer (*Pedionomus torquatus*) detections in the South Australian semi-arid rangelands.

Gerhardy, S[1]. and Finlayson, G.[2]

[1] University of Adelaide, Department of Evolution and Ecology

[2] Bush Heritage Australia

Bird assemblages in the semi-arid rangelands are impacted by boom-bust conditions, with factors such as drought driving behavioural characteristics to assist with survival in challenging environments. In this study, we identify the drought response of a critically endangered bird, the Plains-wanderer (Pedionomus torquatus). Monitoring low density populations of this species are challenging and as such there are significant knowledge gaps in our understanding of the species ecology in South Australia. We used acoustic recorders to monitor Plains-wanderers at Boolcoomatta Station Reserve to investigate response to drought. Twenty-five song-meters have been permanently deployed in a grid since 2018, programmed to record for one-hour periods at dawn and dusk.

Over the 3.5 years of monitoring (2018-2022), the reserve experienced a significant drought (2018-2020) with no Plains-wanderer calls detected during this time, despite birds being observed within the grid. Since the drought broke in 2021, several calls have been detected, including breeding calls. Preliminary results highlight the effectiveness of acoustic devices for detecting change in an open landscape and shed light on to the drought response of Plains-wanderers in an area peripheral to the species' core range. Studies like this are important in furthering our understanding of the behavioural patterns of this critically endangered bird, particularly important as a changing climate will create more variability in rainfall and put further pressure on avifauna in these environments.

Our journey to extracting species lists from long-term recordings by the Australian Acoustic Observatory

Schwarzkopf, L.[1], Allen-Ankins, S. [1], Hoefer, S.[1]

[1]College of Science & Engineering, James Cook University, Townsville, Australia

Passive Acoustic Monitoring is often used to survey a small number of species of interest, but is rarely used to obtain full vocal species lists, comparable to manual or traditional monitoring by bird-watching, trapping and spotlighting, especially from long term recordings. Most studies making such comparisons use manual listening and subsampling to detect species, even in relatively short recordings. To ground-truth the efficacy of the Australian Acoustic Observatory for general vertebrate species monitoring, we conducted traditional surveys at twice a year for 7 days each at each of 6 sites, in the 100m^2 surrounding each audiorecorder. To compare with species lists obtained by manual monitoring, we are attempting to find an automated method of analysing the acoustic data from the same 7-day periods to obtain comparable lists. Here we report the implementation and success of three different automated methods used to obtain species lists. From manual surveys, we have detected 280 vocal species. Building individual classifiers for each species was not possible, due to lack of labelled data, although we continue to label data and have built 2 successful recognisers. Clustering sounds using Kaleidoscope Pro reduced the number of total sounds to analyse by listening, but still required hundreds of hours of listening to label clusters, and was not financially sustainable. Using binary point matching templates in MonitoR has been our most successful detection method to date, successfully producing 88% detections when implemented. Obtaining species lists from long term recordings is likely to become a more common task as audiorecording becomes more common, methods that quickly produce species lists without requiring a lot of specialised knowledge or labelled data.

Improved conservation outcomes for the critically endangered Plains-wanderer through bioacoustic analysis of landscape-scale population dynamics

Aaron Grinter[1], David Baker-Gabb[2], and Karen M.C. Rowe[3].

1. Department of Environment, Land, Water and Planning; Epsom, Victoria

2. Honorary Research Fellow, La Trobe University, Bundoora, Victoria

3. Museums Victoria, Sciences Department, Carlton, Australia and University of Melbourne, School of BioSciences, Parkville, Australia

The Plains-wanderer (*Pedionomus torquatus*) is a small, cryptic ground-dwelling bird that occurs in semi-arid native grasslands through central-eastern Australia, from western Queensland, through central NSW, to northern Victoria. The species is listed as critically endangered under the EPBC Act 1999. A large proportion of the remaining population inhabits the Northern Plains Grasslands of Victoria, itself an EPBC-listed critically endangered ecological community. This landscape is threatened by agricultural cultivation and weed invasion, making habitat quality and availability primary driving factors of the species' success. Population monitoring is hampered by their cryptic nature, making in-person monitoring labour intensive and speculative on a landscape-wide scale. To address this issue, DELWP and Museums Victoria developed a bioacoustic monitoring program, which has been running nearly continuously in 6-monthly rounds since 2017. Our paper reviews the success of this 5-year monitoring program and assesses the effectiveness of a species-level approach for conservation outcomes across the fragile grassland ecosystem. During this period, 74 sites were monitored on both public and private land, with 66 sites monitored for 1-year or longer. We were able to identify 32 sites where Plains-wanderers had not been recorded before, and in 24 of these new sites, we detected breeding attempts. We also documented spatial and temporal variability in calling patterns across the region, with clustered calling and breeding. The temporal data was correlated to seasonal weather, particularly rainfall, increasing our understanding of environmental triggers of breeding. Our results indicate that bioacoustic monitoring is highly effective for Plains-wanderers at a landscape-scale, particularly when used in conjunction with other survey methods such as in-person nocturnal surveys. When used in conjunction with habitat assessment of monitoring sites, valuable data about habitat preferences were gained, which were used to inform land management decisions, ensuring ideal habitat conditions, and driving conservation success.

Acoustic occupancy monitoring of threatened glossy black-cockatoos in bushfire-affected south-east Queensland

Daniella Teixeira[1], Gabriel Conroy[2] and Guy Castley[3]

[1]Queensland University of Technology, Brisbane 4000

[2] University of the Sunshine Coast, Sippy Downs 4556

[3]Griffith University, Southport 4215

The 2019-20 Black Summer bushfires severely impacted feeding and nesting habitat of the south-eastern glossy black-cockatoo, Calyptorhynchus lathami lathami. This led to the subspecies' recent threatened species listing under the Environment Protection and Biodiversity Conservation Act 1999. In south-east Queensland, the areas most affected by the bushfires contained high-value habitat and, as such, impacts on local populations may be serious. To plan management actions, a better understanding of glossy black-cockatoos' use of post-fire landscapes is urgently required. However, monitoring glossy black-cockatoos at large scales is a challenge; they have a large but patchy distribution, they occur in low densities and are typically cryptic in behaviour. In this talk, I will discuss our new project that is using bioacoustics to facilitate occupancy monitoring of glossy black-cockatoos across south-east Queensland's protected areas. Acoustic data, as well as habitat condition data, were collected from over 100 sites. Using open-source sound data from the Australian Acoustic Observatory, we developed a high-performance machine learning recogniser to detect the birds in recordings. Results show that acoustic monitoring greatly improves detection probability and contributes new insights into how these birds use post-fire landscapes. I will discuss the conservation implications of this work and how acoustic methods can aid monitoring of this threatened subspecies.

Assessing acoustic competition between sibling frog species using rhythm analysis

Filer, A. [1], Burchardt, L.S. [2,3] and **van Rensburg, B.J.** [1,4]

[1] Centre for Biodiversity and Conservation Science, School of Biological Sciences, The University of Queensland, St Lucia, Qld, Australia.

[2] Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science, Berlin, Germany.

[3] Animal Behavior Lab, Freie Universität Berlin, Berlin, Germany.

[4] Department of Zoology, University of Johannesburg, Johannesburg, South Africa.

Male frog advertisement calls are species-specific vocalisations used to attract females for breeding. However, it is possible for environmental or biological sounds to overlap with these advertisement calls in both frequency and duration resulting in signal confusion, influencing female decision processes and/or locating abilities. It is therefore important for vocal species competing for the same acoustic space to partition their calls either spatially or temporally (via call alternation or suppression). However, frog species previously isolated from each other may not have developed appropriate adaptive behaviours resulting in direct acoustic competition. This study applied rhythm analysis to track changes in calling behaviour, namely changes in calling frequency, of the wallum sedgefrog and the eastern sedgefrog when vocalising alone versus in the presence of each other to assess potential acoustic competition. Findings demonstrated that both species significantly altered their calling behaviour when exposed to each other. Both species greatly increased the beat of their calls when calling in the presence of each other. We also found evidence of beat development in the wallum sedgefrog whereby there was always a strong initial response in reaction to the first vocal interruption by the eastern sedgefrog, causing an increase in calling frequency rate. These results support the hypothesis that the eastern sedgefrog and the wallum sedgefrog are in direct competition for the acoustic space in habitats where they occur together. This highlights a new threat to the vulnerable wallum sedgefrog species that is protected at a federal level in Australia; and may serve to inform on future management practices. Using rhythm analyses to observe and track changes in acoustic behaviour, especially regarding critical life history events, can help inform on population dynamics such as health, trajectory, and response to management, and therefore be of great benefit to the conservation of vocal species.

The potential for ecoacoustic data to transform our understanding of species distributions

Clemens, R. [1], Alexander, C. [2] and Fuller, S. [2]

[1] EcoCommons Australia, Digital Solutions, Griffith University, Nathan, Australia.

[2] Science and Engineering Faculty, Queensland University of Technology, Brisbane, Australia

Biodiversity decline and the impact of climate change on species are two of the most important environmental issues our society faces. With increasing volumes of biodiversity data and advances in cloud computing, new tools are available to handle and manipulate those data to provide solutions to environmental inquiries. Virtual laboratories have only recently been established in ecology and EcoCommons has developed a platform architecture that can support any modelling workflow. Currently, the most highly developed workflows on EcoCommons are related to species distribution models and future projections of those distributions under climate change.

One of the largest remaining challenges when generating models of species distributions relates to the available occurrence data, which is often not representative of the variety of environments used by a species. While there are a variety of modelling methods to help overcome bias in occurrence data, the best solution is to gather more representative data. Ecoacoustics has the potential to revolutionise the quality of data available for modelling species distributions, especially those that are hard to detect or occur in remote areas.

To improve the Powerful Owl (Ninox strenua) data in southeast Queensland, a species that occurs in remote forests and is hard to detect, 45 acoustic sensors were deployed in areas where Powerful Owl had not been observed previously. A QUT-generated recogniser was run over the data revealing a few new locations where Powerful Owl occurred. We suspect that further deployments at more optimal times of year will identify more owls. Here we demonstrate the profound impact new data can have on a species distribution model, by comparing a model built with existing occurrence records, and one in which we assume Powerful Owls were present at all 45 locations where sensors were deployed. These models are extremely easy to run on EcoCommons.

Application of remote acoustic detection technology enhances wildlife management.

S. Campbell[1], K.N. Armstrong[2], D. Barnard[3] and D. Lucas[4]

[1] Research Scientist, Invasive Species and Environment Biosecurity, Department of Primary Industries and Regional Development, 444 Albany Hwy, Albany 6330 WA, susan.campbell@dpird.wa.gov.au

[2] Specialised Zoological, Adelaide SA, kyle.n.armstrong@gmail.com

[3] DKB Solutions, Perth WA, david.barnard@dkbsolutions.com.au

[4] Lynxemi Pte Ltd, 2 Sims Close, #03-05 Singapore S387298 david.lucas@gmail.com

The application of autonomous detection devices to wildlife management is a burgeoning trend that aims to improve the efficiency of detecting target species, including the early detection of invasive pests and the monitoring of threatened species. However, adoption of such devices into ongoing wildlife management programs requires the technology be reliable, durable, updatable and accompanied by an efficient means of analysing recordings.

Western Australia's (WA) starling (Sturnus vulgaris) management program is unique in terms of longevity (>50 years of near continuous management), scale (>10,000km2) and outcome (starlings are not established in WA). Despite these successes, modelling indicates that additional spatial and temporal surveillance is required to maintain freedom from starlings in WA.

Using a comprehensive reference library of starling calls, we trained a one-dimensional convolutional neural network (CNN) to recognise two call types. The model available for broad-scale deployment was trained with 10,553 calls comprising both starling call types (n = 6,377) and other signals (n = 4,176) from field test sites in South Australia, plus 8,329 non-target signals from WA (Accuracy: 95.5%, Precision: 95.7%, Recall: 95.4%). The device design is based on edge computing principles where processing of captured field sounds are occurs on the device. This design dramatically reduces the amount of data required to be transferred off the device and removes the need for further processing. Via a custom user interface, program managers view high detection probability events sent from devices via Nb-IoT communications to cloud services.

By deploying fully automated, remote, passive acoustic surveillance technology to expand the footprint of starling surveillance in remote locations, we have demonstrated how early acoustic detection could facilitate an effective control response. Further, retraining the CNN with a reference library of Asian Black-spined toad (*Duttaphrynus melanostictus*) calls, has demonstrated the broader applicability of this technology to multiple species.

Bridging bioacoustics and ecoacoustics: revealing ecological patterns in a chorusing frog community.

Sheryn Brodie[1], Slade Allen-Ankins[1], Lin Schwarzkopf[1]

[1]College of Science and Engineering, James Cook University, Townsville Qld, Australia

Ecoacoustic methods provide opportunities for ecological studies of target species within the context of the natural habitats and communities in which they occur. Continuous acoustic monitoring of species assemblages can reveal patterns in breeding phenology, behaviour and interactions. We used long-duration false-colour spectrograms derived from acoustic indices to detect the nightly chorusing of a community of frog species in a tropical savanna in north Queensland. Frogs in these habitats form multi-species aggregations at water bodies during breeding periods when males form large, loud choruses at night to attract females. The chorusing patterns revealed the species have different breeding phenologies, which could be broadly categorised as explosive or prolonged. While rain events were often a trigger for the commencement of the breeding period, species responded differently to weather conditions. Choruses of explosive breeding species occurred only on the night of, or night after, the first high rainfall event of the wet season. The prolonged breeding species showed idiosyncratic patterns of chorusing, which were consistent across sites. Frogs in these unpredictable environments can be difficult to detect in surveys. Fine-grained nightly data on patterns of chorusing and the relationship with environmental conditions allows us to understand the detectability of the presence, or absence, of the frog species in these habitats, and provides baseline data for monitoring and management programs.

Effects of ecotourist noise on an avian community: a case study from a UNESCO world heritage site

Potvin, D.[1], Anderson, M.[1], Watson, N.[1] & Gilby, B.[1]

[1] School of Science, Technology and Engineering, University of the Sunshine Coast, Petrie, Queensland, Australia 4502

Ecotourism has sometimes been criticised as a paradoxical industry, whereby visitors to an area for the purpose of immersion in a local wilderness have an inherently negative effect on the ecosystem and wildlife therein. However, results of studies investigating such impacts are decidedly mixed. One aspect that has been somewhat overlooked in ecotourism research is that of noise, and especially how fluctuations of overall visitors might contribute to background noise present in an area. Furthermore, we do not understand how these noise levels and/or spatially variable human activity within an ecotourist hotspot influence species richness and/or overall assemblages. Here, we use passive acoustic recording over a period of nine months to observe how occupancy, species richness and the make-up of bird assemblages varied over time, especially across periods that correspond with high and low levels of human visitors at a popular ecotourist resort situated within a UNESCO world heritage site and an Important Bird Area as designated by Birdlife International. We found that detected species richness did not fluctuate according to peak tourist periods, however background noise levels were highest during peak tourist season, especially proximate to the main resort buildings. Species assemblages were analysed using non-parametric multidimensional scaling (NMDS) and these were found to be significantly different not only according to spatial proximity to the resort, but also across periods of high and low tourist activity. Thus, while overall bird diversity does not appear to be sensitive to tourist numbers, the composition of species groups is likely highly influenced by such activities. This has implications for the development and maintenance of ecotourist infrastructure attempting to support visitors potentially aiming to see rare or sensitive bird species in an area and highlights that anthropogenic noise should be considered in the context of the ecotourism industry.

Long-term acoustic monitoring of Australian ecosystems

Girola E.[1], EliYahu M.[1], Guru S.[1]

[1] Terrestrial Ecosystem Research Network, The University of Queensland, Brisbane, Australia

The Terrestrial Ecosystem Research Network (TERN) has been collecting acoustic recordings of the environment since 2012 as part of an ongoing, continent-wide program aimed at acquiring long-term environmental data across the country.

Recordings consist of three-hour long, dual channel, 16 bits files, with a sampling rate of 22 or 44 kHz. Recordings are collected at 18 sites representative of different ecosystem types, from arid and semi-arid mulgas to grasslands, grazing pastures, tropical savannas, eucalypt forests, woodlands, and tropical rainforests. Some sites are in remote locations with limited human activity, while others are in close proximity to urban areas. At each site, acoustic data are recorded daily for six hours around dawn and six hours around dusk. This recording schedule aims at capturing the morning and evening bird choruses while minimising battery and memory usage. Recordings are publicly available through TERN's Data Discovery Portal where they can be freely accessed and downloaded by researchers and environmental managers. More than 100,000 audio files are currently available through the Portal.

Long-term spectrograms, acoustic indices and false colour spectrograms are generated from the recordings to aid in identifying sound sources, temporal patterns, long term trends and differences between sites. These are also accessible through the Portal. Although the recording schedule focuses on bird choruses, other sound sources are common, and their prevalence and temporal pattern is characteristic of each site. While wind is the dominant sound source in arid and semi-arid mulgas, bird choruses are the main acoustic contributors in woodlands and eucalypt forests, and rain and insect choruses dominate the soundscape of tropical forests. Anthropogenic sources, such as road traffic and aircrafts can be detected in most areas, albeit their prevalence varies between sites.

Biosecurity: Early detection and community change monitoring using passive acoustics

Simon Linke[1], Chris Wilcox[2], Jens Froese[3], Mike Hodda[4], Daniella Teixeira[5]

[1]CSIRO Land & Water

[2]CSIRO Oceans and Atmospheres

[3]CSIRO Health & Biosecurity

[4]CSIRO National Research Collections Australia

[5]QUT & Bush Heritage Australia

When monitoring for invasives, remote locations can be only reached infrequently so changes in the environment that occur between sampling events can be hard to interpret. Passive acoustic monitoring (PAM) is gaining traction in ecology as a practical and non-invasive approach to surveying ecosystems. PAM is an ideal continuous monitoring technique for invasive species, especially coupled with machine learning detection and classification of sounds and low-cost remote communication technology – sounds emitted by invasive species can be recorded and reported in real-time using in-situ field recorders. Similar technology can also be used for detection of biosecurity threats hidden in opaque media e.g., termites and borers in wood. While PAM has obvious applications in biosecurity, there is no current overarching framework and very sparse example applications.

We identified three key applications: First, detection of soniferous invasives can be used to both monitor eradication success but also detect new invasion fronts of known invaders. We have identified ~30 current invasive species as well as ~15 potential invaders that have been reported in the Indo-Pacific region – all of which can be detected using passive acoustics. Second, long-term monitoring can be used to scan for 'unknown sounds' to avoid future threats. Third, soundscape analysis can be used to monitor change in acoustic communities in response to known or unknown invaders. This has the advantage that the invader itself does not necessarily have to be soniferous – instead a detrimental effect on local birds, frogs or insects can be detected acoustically. In this context we will present a current project that attempts to quantify ecosystem restoration in response to feral pig management in Northern Australia.

Chorusing behaviour of frog communities in response to environmental flow in Gwydir River catchment, Australia

Mohammad Abdur Razzaque Sarker[1], Donald T. McKnight[1,3], Darren Ryder[1], Amelia Walcott[2], Joanne F. Ocock[2], Jennifer A. Spencer[2], David Preston[2], Sheryn Brodie[3], and Deborah S. Bower[1]

[1]School of Environmental and Rural Science, University of New England, Armidale, NSW 2350, Australia

[2]Environmentand Heritage Group,Department of Planning and Environment, Sydney NSW2000, Australia

[3]La Trobe University, Department of Environment and Genetics, School of Agriculture, Biomedicine and Environment, Wodonga, VIC, Australia

Globally, river regulation has degraded wetlands, and continues to threaten wetland dependent biota including parts of the Murray-Darling Basin (MDB), an ecologically significant drainage basin in Australia. Frogs in floodplain wetlands largely depend on habitats created by river flows but little is known about how frog chorusing activities, a measure of potential breeding behaviour, are impacted by river regulation and vary in response to wetting and drying cycles in the northern MDB. Frog chorusing activity is highly variable and is cued, in part, by environmental factors. In floodplain wetlands, river flow drives frog breeding responses for many species. We examined how the overnight long-duration chorusing behaviour of frog communities varied in response to the inundation of wetlands. We also tested the influence of additional environmental variables such as air temperature and rainfall. We used passive acoustic recorders to record and compare 14 hours of nightly soundscapes for four days before and after the arrival of river flows following environmental water delivery which inundated the wetland survey sites. Our result indicate that total species richness of chorusing frogs increased after the arrival of river flows, six species chorused over the four nights preceding and eight species chorused following the flow arrival, but the responses varied among species and sites. After inundation, the choruses of Limnodynastes tasmaniensis significantly increased whereas Limnodynastes fletcheri decreased. Most species were detected before and after flow, but one species (Cyclorana alboguttata) was only detected before flow, and three species (Cyclorana verrucosa, Cyclorana cultripes, and Limnodynastes salmini) were only detected after flow. Our study revealed complex overnight chorusing behaviour in wetland-dependent frogs in response to wetland inundation. Based on our findings we conclude that, environmental watering may help initiate breeding of different frog species.

Considerations for landscape monitoring of forest fauna using acoustics

Gonsalves, L. [1], Law, B [1]. and Slade, C. [2]

[1]Forest Science, NSW Department of Primary Industries, Parramatta, NSW, Australia.

[2]Forestry Corporation of NSW, Wauchope, NSW, Australia.

Landscape-scale monitoring is a key approach for assessing the status of fauna populations. However, great care needs to be taken to collect rigorous data and avoid wasting resources. We report on a pilot study that collected data to inform key parameters that require consideration when designing a landscape monitoring program for fauna. This included seasonal (spring/summer vs autumn/winter) detection probability and occupancy for selected vocalising arboreal mammals (koala, yellow-bellied glider) and forest owls (powerful owl and sooty owl) as well as echolocating bats when sampled using remote sensors and automated call ID (acoustics and ultrasonics). Using these parameters, we were able to evaluate trade-offs between having multiple sensors per site vs a reduced sampling intensity and assess the required sampling effort (number of sites) to achieve a desired power (0.8) for detecting trends (-30 % in 10 years). Our results indicated that there were seasonal differences in detection probability for some species (e.g., powerful owl detection probability was 3-times greater in autumn/winter). As such, some level of sampling should occur in both seasons. The influence of the number of sensors per site on detection probability varied by species. If sampling extends over a two-week period, >90 % probability of detection is achieved for most species using two sensors per site. Nevertheless, detection probability should be incorporated in analyses (e.g., via occupancy modelling). The results of this pilot study suggest that landscape-scale monitoring for forest fauna is achievable using cost-effective remote sampling techniques that generate 'repeat visit' data needed to account for imperfect detection.

Progressing deep learning species call recognition from a research topic to an everyday tool.

Griffioen, P., Francis, L. [1]

[1] Arthur Rylah Institute for Environmental Research. Department of Environment, Land, Water and Planning, Victoria.

Learning algorithms are proving to be very useful tools for species identification with Convolutional Deep-Learning Neural Networks (CDNNs) providing very high levels of accuracies. The challenge now is to transfer high performance models from the research domain into production environments. To achieve this will require changes in the workflow for model development for species detection and the subsequent implementation of these models into user-ready software products.

We have designed a robust CDNN and embedded these in a software system to detect multiple species efficiently and accurately from field recordings. The workflow within the software includes exemplar identification, tagging, and collation of exemplars into a database. Models are development with a robust 1-dimensional CDNN form which interfaces directly with the database for species inclusion, exemplar extraction, and tracking of model design and performance. Production-level processing of field recordings and call identification validation are also included in the software system.

We have used this system to develop models for detecting 16 Victorian frog species (overall accuracy 96%), 17 bat species (88%) and Eastern Bristlebirds (96%) and utilised it on more than 20Tb of sound recordings at processing rates up to 400 seconds/second. This system lends itself to efficiently producing custom tools for a wider suite of species.

Using acoustic arrays to cost-effectively estimate density

Law, B. [1], Gonsalves, L. [1], Burgar, J. [2], Brassil, T. [1] and Roe, P. [3]

[1] Forest Science NSW Department of Primary Industries, Parramatta, NSW, Australia

[2] University of British Columbia, Vancouver, Canada.

[3] Science and Engineering Faculty, Queensland University of Technology, Brisbane, Australia.

Passive acoustics are widely applied to survey vocal fauna with a common metric being modelled probability of occupancy after accounting for imperfect detection. Often more detail is desired on populations at a local scale, such as estimating density and how this varies spatially at a site. Spatially explicit mark-recapture and time of arrival methods have been used for modelling density from acoustic data when the identity of individuals is known. However, identifying vocalisations from individuals is not straightforward, nor always possible. Spatial Count provides an alternative method for estimating density when the identity of individuals is not known. We outline a validation case study on koalas to demonstrate plausible estimates of density are possible from an acoustic array and Spatial Count modelling. We also present examples of its implementation to assess change in koala density in relation to the black summer megafires in difficult, forested terrain and across private land where frequent intrusion of researchers to survey fauna is not always desirable. Opportunities to improve the precision of the method will also be discussed.

Acoustic restoration: Using soundscapes to benchmark and fast-track recovery of ecological communities

Watson, D.M.[1] and Znidersic, E.[1]

1 Gulbali Institute, Charles Sturt University, Albury, Australia

As catastrophic wildfires, heatwaves and storms increase in frequency and severity, ecosystems face mounting pressures, pushing relictual populations towards local extinction. Current restoration approaches were originally developed as site-scale secondary interventions—removing primary stressors and relying on regeneration to do the rest. While these passive methods have made way for active interventions, most are too effort-intensive to apply beyond individual site scales. Innovation is urgently needed to develop scalable and rapidly deployable methods to arrest further declines, complimenting existing interventions to facilitate recovery.

After a sustained period of development and growth, a critical mass of ecoacoustic research and practice has been attained, evidenced by large-scale investment in infrastructure, international data-sharing networks and adoption of standard operating procedures to maximise comparability. An idea that emerged from our use of sound to survey both species and communities over the past decade is to reimagine this monitoring tool as a proactive restoration approach. We name this new field “acoustic restoration”, emphasising soundscapes as holistic high resolution digital depictions of ecosystems, recognizing the biological, geophysical and socio-cultural values they encapsulate.

Here we introduce the idea and develop four elements of this novel transdisciplinary domain. The first broadens existing use of acoustic lures to attract single species up to entire assemblages, broadcasting soundscapes to fast-track recolonization of communities from the top down. The second element uses increased animal visitation to augment the rain of seeds, spores, bacteria and fungi re-inoculating aquatic and terrestrial communities, restoring ecosystems from the bottom up. Third, we suggest sound represents an ideal benchmark for restoration, providing an independent and verifiable means of answering the question—are we there yet? Finally, we advocate using soundscapes as evocative engagement tools to remind stakeholders what their river, reef or rainforest sounded like and create new ways to reconnect with places they hold dear.

Linking acoustic indices with avian biodiversity on the New England Tablelands: a cautionary tale from a multi-year dataset

McDonald, P. G.[1], Allen-Ankins, S.[2], Barati, A.[1]

[1] Animal Behaviour and Ecology Lab, Zoology, University of New England Armidale, Australia

[2] College of Science & Engineering, James Cook University, Townsville, Australia

Bioacoustic indices offer great promise as an efficient means of automating the extraction of biodiversity information from large acoustic datasets. Despite this, the use of indices remains an area of intense research and careful ground-truthing of their applicability is required prior to their use in a given area. We therefore explored the relationships between woodland bird biodiversity and acoustic data collected over a three year period at 50 2ha sites located on Travelling Stock Routes throughout the New England Tablelands in north-eastern New South Wales.

Five surveys a year, beginning in the winter of 2019, were conducted by experienced ornithologists at each 2ha site, resulting in over 1000 manual surveys describing avian diversity and abundance. Acoustic data was simultaneously collected at each site using a centrally placed passive acoustic recorder. Surprisingly, while manual surveys demonstrated anticipated patterns in avian diversity and abundance, such as peaks during spring, comparisons with more than 20 bioacoustic indices resulted in generally very low and non-statistically significant correlations with both avian diversity and abundance onsite. Multi-index models did not improve these comparisons, nor did restricting the dataset to single years or distinct temporal windows (e.g., dawn chorus). Further, indices also performed poorly in differentiating between sites based on the presence or absence of Noisy Miners (Manorina melanocephala), a species known to drive biodiversity reductions in areas it occupies.

Taken together, our results indicate caution in the widespread use of acoustic indices without local ground-truthing assessments. Much remains to be understood regarding the conditions and factors that shape both within- and between-site variations in bioacoustic indices, and how these relationships can be harnessed to automate assessment of biodiversity more broadly.

Poster Abstracts

Automatically Detecting Features from Big Environmental Audio with Frequency Preserving Autoencoders

Rowe, B., Eichinski, P., Zhang, J. and Roe, P.

Faculty of Science, Queensland University of Technology, Brisbane, Australia

Continuous audio recordings are playing an ever more important role in conservation and biodiversity monitoring, however, listening to these recordings is often infeasible, as they can be thousands of hours long. Automating analysis using machine learning is in high demand. However, these algorithms require a feature representation.

Several methods for generating feature representations for these data have been developed, using techniques such as domain-specific features and deep learning. However, domain-specific features are unlikely to be an ideal representation of the data and deep learning methods often require extensively labeled data.

We propose a method for generating a frequency-preserving autoencoder-based feature representation for unlabeled ecological audio. We evaluate multiple frequency-preserving autoencoder-based feature representations using a hierarchical clustering sample task. We compare this to a basic autoencoder feature representation, MFCC, and spectral acoustic indices. Experimental results show that some of these non-square autoencoder architectures compare well to these existing feature representations.

Continental scale biodiversity assessment through combined acoustic and satellite remote sensing

Marina D. A. Scarpelli[1], Paul Roe[1], David Tucker[1], Susan Fuller[1]

[1]Faculty of Science, Queensland University of Technology, Brisbane, Australia

Climate change, habitat fragmentation and habitat loss are having significant impacts on ecosystems at unprecedented levels, requiring the immediate and ongoing survey of biodiversity. A monitoring approach that can provide comparable and continuous assessment across ecoregions is required if we are to document changes in biodiversity over time and at large spatial scales. In this study, we used a combination of passive acoustic and remote sensing tools to deliver a scalable approach for monitoring biodiversity across five different ecoregions in Australia, as well as to identify the key drivers of patterns in biodiversity including land-use and cover changes, and climatic variables. The results have revealed that the acoustic activity of birds and insects was most influenced by the vegetation type at each recording location. Landscape metrics (i.e., connectivity, total natural cover, and core area) and temperature also influenced bird and insect patterns, but to a lesser degree. The use of high-level taxonomic groups provided comparable results across different ecoregions, showcasing the value of this approach for the analysis of big datasets generated through long-term acoustic monitoring platforms such as the Australian Acoustic Observatory. This approach has also revealed that local anomalies, such as missing taxonomic groups at given sites, can be detected using a continental-scale monitoring program. Unlike most other biodiversity monitoring approaches, remote and continuous surveys are possible using passive acoustic monitoring, capturing a permanent record of soniferous fauna. Furthermore, combining biodiversity information from acoustic recordings with satellite imagery enables the assessment of faunal biodiversity and vegetation changes across regions. We recommend that continuous, continental-scale acoustic recording, combined with remote satellite sensing, should be incorporated into an ecosystem monitoring plan for long-term assessment of Australia's biodiversity.

Measuring frog communities with acoustic sensing across a sub-tropical urban matrix

Stephen Molan, Dr Laura Grogan, Dr Clare Morrison, Dr Chantal Lanctôt, Prof Hamish McCallum

Griffith University, Frog Research Team Eastern Australia

Urbanisation presents many parallel threatening processes for wildlife which exist within urban landscapes. As a taxon, frogs may be particularly prone to these threats due to their sensitivity to changes in the environment and their dependence on aquatic and terrestrial habitat. Within Australia, south-east Queensland is a hotspot of frog diversity, with over 20 native species being found within the state capital of Brisbane and many more within the mountainous sub-tropical rainforests nearby. I aimed to detect whether frog community composition and calling activity changed across an urban matrix over a five-week survey from 16 August – 17 September, when calling activity is generally low. I chose four rural, four medium and four urban study sites within Brisbane, and one remnant site in Lamington National Park, Queensland.

Community composition was measured via *in situ* visual and environmental surveys, while calling activity was derived from cluster analysis of a ubiquitous frog species, *Litoria fallax.* I also derived five acoustic indices of the audio dataset: normalised difference soundscape index (NDSI), acoustic complexity index (ACI), acoustic diversity index (ADI), acoustic evenness index (AEI) and biodiversity index (BI) and aimed to determine how these measures of sonic diversity responded to frog acoustic activity. I selected the most parsimonious linear mixed effects models to find the effect of environmental variables on frog species richness and *L. fallax* weekly calling intensity. Additionally, I used linear fixed effects models to determine which aspects of the soundscape were significantly affected by *L. fallax* calling intensity.

There was no monotopic relationship found between level of urbanisation and frog species richness in this study, however, the final linear mixed effects model for *Litoria fallax* calling intensity contained level of urbanisation and submerged vegetation cover as fixed effects. This indicated that species richness may respond to landscape-scale processes more than local-scale processes. Acoustic indices of NDSI, ACI and BI were all significantly affected by *L. fallax* calling intensity. Due to the short study period, results presented here should be interpreted cautiously, as amphibian assemblages generally change over seasonal time- scales. Future studies should be conducted over a longer time period over peak activity seasons for frogs and should include landscape-scale determinants of urbanisation to better evaluate the impacts of urbanisation on this important taxonomic group.

Using acoustic data to resolve species boundaries in lyrebirds, the masters of mimicry

Yasara de Mel[1], S. Fuller[1], D. Hurwood[1], M. Phillips[1],
[1]Queensland University of Technology, Brisbane, Australia

Birds depend on acoustic communication for mate recognition, as a display of genetic fitness and consequently mate selection. The change in bird calls over geographic ranges which lead to unique dialects has been studied in many bird species. As an examination of a living fossil taxon in Australia, this study has focused on the phylogeography and vocalisations of lyrebirds (Menura), a genus renowned for diverse vocal repertoires. Genetic data obtained in this study have confirmed that Albert's and superb lyrebirds are separate species, but also identified a hybridization event between them and showed that superb lyrebirds are separated into two populations, north and south of the Hunter Valley. Consequently, the variation in call structure across boundaries between the species and proposed sub-populations of superb lyrebirds' range requires investigation. No study has yet compared the call characteristics and variation between these two relict lyrebird species native to Australia. This study will examine whether calling varies with distance from species/population boundaries, potentially indicating character displacement and reinforcement of mating barriers or alternatively, convergence and breakdown of barriers. Vocalisations have been recorded using SM3 BAT song meters in national parks across the range of both species including the putative admixture zone. These recorders were set to record for 3hours covering 30 min before dawn to 2.5 hours after dawn between May-July 2022 during the breeding season. Preliminary results based on manual analysis of call elements (e.g., delta frequency, time between notes, overall call duration, number of notes) will be presented.

Species Classification Using Deep Learning Signal Processing Techniques in Large-Scale Natural Soundscapes

Napier, T.[1], Schwarzkopf, L.[1], Lee, I.[1], Ahn, E.[1] and Allen-Ankins, S.[1]

[1]College of Science & Engineering, James Cook University, Townsville, Australia

Computational ecoacoustics has seen rapid growth in recent decades due to a reduction in costs of digital sound recording devices and data storage, enabling continuous passive acoustic monitoring of populations of vocal fauna. While the collection of ecoacoustic data has become easier, species labelling from audio recordings remains a significant challenge. In the past few years, Deep Learning (DL) based approaches to this problem have been the State of The Art (SoTA), and much of this increase in accuracy has come from the advancement of image classification techniques, especially the use of Convolutional Neural Networks (CNN) in vision-based problems.

However, the large issue with many existing Machine Learning (ML) and DL approaches to this issue, is that they are evaluated on datasets with low variation amongst different taxonomic groups such as birds, and anurans, which is not representative of the real world. Existing techniques rely on smaller test datasets with lower biodiversity and acoustic complexity, unlike real-world applications which must accommodate for such complexities to be genuinely useful. This work aims to find useful and novel solutions to this problem by using a combination of clustering and deep learning to develop an automated species segmentation and classification network from Australian Acoustic Observatory audio recordings.

To date, the most pressing issue halting further progress is the need of a labelled ground-truth dataset representative of the complete soundscape of A2O. Our preliminary findings indicate that using unsupervised learning can assist the automatic annotation of multiple sounds in a single A2O audio recording. However, for longer sequences, further experimentation with self-supervised learning approaches may allow for increased accuracy gain from unstructured samples without the need for manual data labelling.

Using Passive Acoustic Monitoring and Deep Learning Tools to Detect a Cryptic Threatened Owl (*Ninox strenua*)

Alexander, C[1], Clemens, R.[1], Fuller, S[1]

[1]School of Biological and Environmental Science, Queensland University of Technology, Brisbane, Australia.

Passive acoustic monitoring is becoming a more common tool for surveying vocalising species of conservation concern, however there are still relatively few avian field-studies utilising automated methods with success. In this study, we utilised passive acoustic monitoring and an open-source deep learning approach to develop an automated acoustic recogniser for a cryptic threatened owl species (the Powerful Owl, *Ninox strenua*). Traditionally this owl has been monitored using call playback and visual observation, a logistically challenging and ineffective approach across large spatial scales for a species that is wide-ranging, low in abundance and nocturnal. This study involved placing low-cost acoustic recorders in active Powerful Owl territories and manually annotating the recorded call data to form a training dataset for development of a deep learning acoustic call recogniser. Two models were trained for different owl age-classes so that the recogniser can be used to distinguish between adult and chick detections. This methodology has the potential to significantly reduce monitoring time and allows ~150 hours of data to be visually reviewed in a matter of minutes. This allows the recogniser to be used for monitoring adult distribution, as well as breeding success, two important knowledge gaps for this threatened species. The deep learning model exhibits high precision and recall rates, reasonably fast processing and the associated scripts allow for rapid review times. The benefits of this approach include scalability, monitoring of remote and difficult to access terrain, non-invasiveness and ethical survey, efficient monitoring, and accurate data collection allowing improved conservation management of Australia's largest, threatened owl. Practical testing on multiple 700+ hour datasets have confirmed the value of these tools for conservation, whereby owls were detected at a site where they had not detected in multiple aural surveys.

Vocalisation patterns of the Eastern Ground Parrot (*Pezoporus wallicus wallicus*) and implications for acoustic monitoring efforts

Lana Prior*[1], Kieran Aland[2], Alexis L. Levengood[1] & Dominique A. Potvin[1]

[1]School of Science and Engineering, University of the Sunshine Coast, Queensland, Australia

[2]Queensland Museum, South Brisbane QLD 4101, Australia

Vocalisations are a key component of communication for species that employ crypsis, allowing them to maintain relationships while avoiding observation or detection by predators. The Eastern Ground Parrot (*Pezoporus wallicus wallicus*) is one such species that lives within dense heathland habitats in eastern mainland Australia. Understanding vocalisation patterns of this species can provide insight into their ecology, behaviour and population status. Passive acoustic monitoring (PAM) is now a standard methodology used for avian monitoring and conservation programs. For implementation of these methods to be successful, we require a minimum level of understanding of the environmental and behavioural factors that may influence vocal activity. We used previous descriptions of vocalisations of the Eastern Ground Parrot to visually identify their calls. We then tested how call rate fluctuated across key temporal, environmental and meteorological variations over one year using passive acoustic recordings. We found that season, time of day and days since rainfall significantly predicted calling activity of the birds. Interestingly, these parrots called at significantly higher rates during full moon phases, particularly in Autumn. Increased call rates could be reflecting behavioural changes associated with changes in environmental resources across different seasons along with the light availability differences across moon phases. The results demonstrate the importance of considering environmental conditions when extrapolating PAM data to inform conservation aims, since conditions may contribute to the over- or under- estimation of numbers depending on habitat factors that may influence overall behaviour not only in the Eastern Ground Parrot, but also more generally.

Automated Acoustic Detection of Threatened Birds with Complex Vocal Repertoires

Lance De Vine, Callan Alexander, Paul Roe Susan Fuller

Queensland University of Technology

Deep learning is increasingly being explored as a solution for automated species detection in passive recordings. However, species with highly variable vocal repertoires pose considerable challenges for automated detection. This study uses deep learning to automatically detect two threatened species: Eastern Bristlebird (northern ssp.) and Albert's Lyrebird. These two species are known for their complex and highly variable vocalisations. We show that species with complex vocalisations can be reliably detected using binary classifiers by targeting specific repeated vocalisations. The classifiers have strong F1 scores with a focus on high precision to minimise false positive detections. The automated detection software (NEAR – Neural EcoAcoustic Recogniser) is designed to process data rapidly and will allow for significantly improved threatened species monitoring, particularly in remote areas.

Advertisement call variation in *Litoria wilcoxii* and *L. jungguy*

Andrew Schwenke, David Hurwood, Susan Fuller.

Queensland University of Technology

In contrast to most Australian hylids, *Litoria wilcoxii* and *L. jungguy* lack a vocal sac, and produce low intensity calls. Despite this, males call from beside stream edges, where environmental noise is high. Hence, there is currently limited knowledge on their calling properties. As a result, how they can communicate successfully, and the adaptative pathways between this call and the acoustically constraining environment are unclear. Hybrids between *L. wilcoxii* and *L. jungguy* have also been identified, and the hybrid zone between these species presents an opportunity to gain insight into the evolution of their acoustic signals.

Advertisement calls for both species were recorded and analysed, across south-east Queensland and the Wet Tropics. Analysis revealed three clusters corresponding to *L. wilcoxii* from south-east Queensland, *L. wilcoxii* from the Wet Tropics, and *L. jungguy. Litoria jungguy* showed differences in their pulse durations, which was classified as being a static trait (low intra-individual variation) and could therefore be under stabilising selection for mate recognition. Nevertheless, there was overlap in many call properties between *L. wilcoxii* from within the hybrid zone and *L. jungguy*, demonstrating incomplete divergence in advertisement calls between the two taxa. Overall, the study provided a better understanding of the advertisement calls in these species, providing a foundation for understanding potential factors which may have and likely continue to influence the evolution of these signals.

FRONTIER LABS

Solar BAR

Solar Powered Bioacoustic Recorder

With a battery that never needs replacing, the Solar BAR enables continuous bioacoustic monitoring for years at a time with the same performance and durability as the BAR-LT.

- Built in solar panel & charge controller
- Up to 4TB of storage (across 4 x SD slots)
- Built in GPS time-sync and location
- 16-bit WAV or FLAC lossless compression

BAR-LT

Bioacoustic Recorder

Outstanding audio quality, legendary reliability, and clever design for extended deployments. The BAR-LT is the feature packed, zero compromise recorder of choice for bioacoustic studies everywhere.

- Up to 1000 hours of recording
- Up to 4TB of storage (across 4 x SD slots)
- Built in GPS time-sync and location
- 16-bit WAV or FLAC lossless compression
- Camouflaged, rugged and waterproof

GET MORE FROM YOUR BIOACOUSTIC RECORDERS!

FOR EVERYTHING YOU CAN'T SEE...

ACOUSTIC RECORDERS

Wildlife Acoustics Song Meter Recorders & Kaleidoscope Analysis Software

Record & analyse birds, bats, & frogs

CAMERA TRAPS

Reconyx HyperFire 2 & UltraFire Professional Trail Cameras

Capture high-definition images & video

faunatech

A WILDLIFE ACOUSTICS COMPANY

Scan to learn more