Project Overview

Improving our ability to monitor fauna in forests with acoustic technology in northern NSW

Forest Monitoring and Improvement Program - Foundational Projects

Project details

Project title
Improving our ability to monitor fauna in forests with acoustic technology in northern NSW
Project summary

Direct monitoring of fauna is highly valuable because it provides trend patterns that can be readily interpreted by the public and integrated with ESFM indicators. Improvements in technology have seen remote sensors (e.g., infrared cameras, acoustic and ultrasonic recorders) widely used in fauna survey, aided by the ongoing development of automated tools to rapidly and reliably process large volumes of data that may be generated by these sensors.

The project will support analysis and reporting of trends in fauna species (including koalas) occupancy since 2015 in public forests. It will also support an assessment of the changing status of koala populations as measured by occupancy, including after 2019 wildfires where one array (25 Song Meters) from a pair was burnt allowing estimates of a change in koala density.

The specific outcomes of the project will include:
- Development and testing of cost-effective methods for robust occupancy monitoring of vocal forest fauna across multiple northern NSW sites, based on continuation of 60-70 sites surveyed per annum in modelled koala habitat of the north-east forests (~1.66 million ha's).
- Continued occupancy monitoring of koalas cross-tenure (and recording of other fauna) to enable to allow for trend analyses to be undertaken over time.
- Robust occupancy trends for koalas and, with continued development, other individual species over a wide area, achieved by a very cost-effective method, is an expected outcome.
- Project results will be presented as a report, which will form the basis of a peer-reviewed paper and the annual stakeholder forums under the NSW Forest Monitoring and Improvement Program each September.

The project will support continued monitoring of > 60 sites/year and establish additional sites using monitoring devices (song-meters and anabat detectors) to enable broad trend monitoring of fauna species across public forests of north-east NSW. This proposal won't expand the original study region, but will add additional sites to ensure sampling across tenure is more evenly balanced. According to sampling power analyses undertaken for koalas (Gonsalves and Law unpubl. data), a minimum of 60 sites per year should be monitored to ensure trends can be detected. From Law et al. (2018)[1], 171 sites (62 different SFs; 32 different NPs/NRs) have been sampled. In 2018, eight sites were sampled in National Parks and the remainder were in State Forest. This project aims to ensure additional sites are sampled National Park to balance sampling across tenures.

This project will fund equipment to expand monitoring established on State Forests and National Park forest sites as part of ongoing biodiversity trend monitoring and provide an analysis of trends for the first 5-6 years of monitoring, focusing on koalas.

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[1] Law, B.S, Brassil, T, Gonsalves, L, Roe, P, Truskinger, A, McConville, A (2018) 'Passive acoustics and sound recognition provide new insights on status and resilience of an iconic endangered marsupial (koala *Phascolarctos cinereus*) to timber harvesting', PLoS One, 13(10)

Also, one pair of Song Meter arrays surveyed in 2018 by DPI Forest Science Unit at Bellangry and Bril Bril State Forests will be re-surveyed after the Bril Bril array was burnt by a large wildfire in August – September 2019. This will provide information on the impact of wildfires on koala density and site re-occupation.

Results will also be shared through annual stakeholder forums under the NSW Forest Monitoring and Improvement Program and the data reported publically through the BioNet Atlas.

Project objectives

The project aims to continue to monitor a network of song meter sites to enable efficient, ongoing and scalable trend monitoring for a variety of fauna species. Acoustic and ultrasonic sensors will be deployed simultaneously at the same sites in spring as per previous surveys to target koalas. This is also an ideal time for recording bats and calls of other species, including yellow-bellied glider, powerful owl, sooty owl, boobook owl, and sugar glider. Monitoring of frogs would be considered however this is likely to require different sites at creeks or water bodies. Sound files will be stored for future analysis as recognisers for additional species are developed, through a proposed ARC-linkage project with the Queensland University of Technology Ecosounds Laboratory (An End-User Framework for Evolving Fauna Call Recognisers). While the aim of this project is to sample public land opportunities for sampling on private land in rural-urban forested areas will also be sought. Sampling private land using acoustic arrays is currently underway across 50 sites in northern NSW and further approvals for re-sampling and occupancy analysis will be sought in the future.

Outline of project methods

Acoustic sensors are highly suitable for koala (Hagen et al. 2018[2]; Law et al. 2018[3], Law et al. in press[4]) and other vocal fauna species' monitoring potentially including the Powerful Owl, Sooty Owl, Barking Owl, Boobook Owl, Yellow-bellied Glider, Squirrel Glider, Sugar Glider, Giant Barred Frog, Stuttering Frog, Giant Burrowing Frog, Mountain Frog species, Hip-pocket Frog and diurnal bird species, noting that frogs would need to be targeted in different habitats. The technique offers consistent repeatability, is highly efficient and readily scalable (e.g. Rodhouse et al. 2012[5]; Law et al. 2015; Willacy et al. 2015[6]; Campos-Cerqueira and Aide 2016[7]; Buxton et al. 2018[8]; Williams et al. 2018[9]; Wood et al. 2019[10]). The technique can be adopted across multiple tenures and new sites readily added at any time. Song meters can be used for multiple species and sound files will be retained for future analysis as additional species' call recognisers are developed. The use

[2] Hagens, S.V., Rendall, A.R. and Whisson, D.A. 2018. Passive acoustic surveys for predicting species' distributions: Optimising detection probability. PLoS ONE 13(7): e0199396. https://doi. org/10.1371/journal.pone.0199396
[3] Ibid.
[4] Law, B., Gonsalves, L., Bilney, R., Peterie, J., Pietsch, R., Roe, P. and Truskinger, A. (in press) Using passive acoustic recording and automated call identification to survey koalas in the southern forests of New South Wales. Australian Zoologist.
[5] Rodhouse, T. J., Ormsbee, P. C., Irvine, K. M., Vierling, L. A., Szewczak, J. M. and Vierling, K. T. (2012), Assessing the status and trend of bat populations across broad geographic regions with dynamic distribution models. Ecological Applications, 22: 1098-1113. doi:10.1890/11-1662.1
[6] Willacy, R. J., Mahony, M. and Newell, D. A. (2015), Breeding Phenology of *P. richmondensis*. Austral Ecology, 40: 625-633. doi:10.1111/aec.12228
[7] Campos-Cerqueira, M. and Aide, T. M. (2016), Improving distribution data of threatened species by combining acoustic monitoring and occupancy modelling. Methods Ecol Evol, 7: 1340-1348. doi:10.1111/2041-210X.12599
[8] Buxton, R.T., Lendrum, P.E., Crooks, K.R., Wittemyer, G. (2018) Pairing camera traps and acoustic recorders to monitor the ecological impact of human disturbance. Global Ecology and Conservation 16, e00493, https://doi.org/10.1016/j.gecco.2018.e00493
[9] Williams, E.M., O'Donnell, C.F.O., and Armstrong, D.P. (2018) Cost-benefit analysis of acoustic recorders as a solution to sampling challenges experienced monitoring cryptic species. Ecology and Evolution. 2018; 1–10.
[10] Wood, C. M., R. J. Gutiérrez, M. Z. Peery. 2019a. Acoustic monitoring reveals a diverse forest owl community, illustrating its potential for basic and applied ecology. Ecology 100(9): e02764.

of song meters and anabat detectors allow for upscaling of monitoring programs with multiple sample sessions undertaken using the same devices with replacement batteries and data cards downloaded, enabling many sites to be sampled per season. As more call recognisers are developed additional species will be able to be analysed with sound files already recorded from previous surveys.

Power analyses for acoustic monitoring of koalas based on existing Song Meter data (Gonsalves and Law unpubl. data), indicate > 60 sites per year across the north-east forests (~ 1.66 million ha's), are needed for rigorous occupancy monitoring, when used in conjunction with a habitat map for the north-east forests (i.e. Law et al. 2017) [11]. For occupancy surveys of koalas seven nights provide an adequate sampling period (Law et al. in press)[12].

In addition, a recent opportunity just emerged to re-survey one pair of Song Meter arrays (25 Song Meters each grid) that were surveyed in 2018 by DPI Forest Science Unit at Bellangry/Bril Bril State Forests's 15 km north west of Wauchope northern NSW. The aim of that survey was to trial estimating koala density using habitat assessments, scat surveys and a grid of Song Meter arrays. Although these analyses have not yet been completed, very high koala activity levels were recorded (Law unpubl. data). The Bril Bril array was subsequently burnt by a large wildfire in August – September 2019[13], so re-surveying before the end of the koala breeding season in 2019 (November) would provide valuable data on the impact of this wildfire, noting that the second array is adjacent and did not burn. Each array comprised 25 Song Meters with a 500 m spacing, set for 10-14 days. Additional budget has been requested to provide resources for a contractor to deploy and retrieve Song Meters at these arrays.

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[11] Law B, Caccamo G, Roe P, et al. (2017) Development and field validation of a regional, management-scale habitat model: A koala Phascolarctos cinereus case study. Ecology and Evolution 7:7475–7489. https://doi.org/10.1002/ece3.3300
[12] Ibid.
[13] Walters Trail 2 wildfire, ICON Incident Number 19081043845, 1503 ha.

Additional species' call recognition software development is being undertaken through a separate project, under an existing collaboration with Queensland University of Technology, including an ARC linking grant and as such is not included in the scope of this project.

Expected project outcomes

The project is expected to monitor and deliver analysed trends of occupancy levels for koalas with sound files archived for analysis of other fauna once additional call recognition software is available. The cost-effective nature of the method provides a robust repeatable technique which adjusts for variance over the sampling period. The readily deployable nature of song-meters also permits site periodic re-sampling to allow for trend analyses to be undertaken over time.

Robust occupancy trends for individual species over a wide area, achieved by a very cost-effective method, is an expected outcome.

Results will be presented as a report, which will form the basis of a peer-reviewed paper. Results will also be shared through annual stakeholder forums under the NSW Forest Monitoring and Improvement Program.

Demonstration of how project objectives contribute to the overall NSW Forest Monitoring and Improvement Program Framework

The State-wide and Coastal IFOA monitoring programs currently in development under the oversight of NRC, both have aims of understanding trends in occupancy of various species including vulnerable and threatened species that produce audible and ultrasonic calls. The technique of using song meters and or ultrasonic bat detectors are established for some taxa, but emerging in others, but all align directly to these aims by being able to generate reliable and transparent data on occupancy levels for multiple species, including the iconic Koala, through a cost effective and highly repeatable technique.

Major wildfires on the NSW north coast and northern tablelands in 2019 have burnt a number of sites monitored as part of the NSW Koala Strategy research program (e.g. Royal Camp, Carwong, Braemer State Forests) and this presents an additional need to gather data on the impacts of these fires by ensuring these sites continue to be monitored. Wildfire is a major and extensive disturbance to Koala populations and its impacts are a priority for monitoring in forests. Wildfire extent around each site can be included as a covariate in occupancy analyses to reveal its influence over time.

Collaboration will be sought with Dr Martin Predavec (DPIE) for alignment with NSW Koala strategy during strategic site selection. In addition, expert peer review will be sought through the existing koala expert panel already in place for Koala research projects being managed the NRC. Data obtained through the project will be made publicly available and will ultimately be published as a peer-reviewed paper of koala trends over 5-6 years, with preliminary results presented at a scientific conference.

Demonstration of how the proposal will answer the fundamental evaluation question - How is the occupancy of fauna in forests changing over space and time?

The need for understanding koala and other fauna species population trends is high and required across all tenures of NSW. This project will establish an ongoing monitoring program for koalas that will also enable other species to be sampled as part of monitoring programs and adaptive management / effectiveness programs developed as part of the Coastal IFOA requirements and State-wide monitoring programs.

Song meter deployment and retrieval requires 2 visits, does not require highly skilled observers and provides for a scientifically valid repeat sampling methodology. This allows for drastic cost efficiency improvements over historical techniques providing for greatly increased sampling opportunities to contribute to the knowledge of species' occupancy trends across NSW.

Song meters collect vocalisations from a wide range of species and these sound files can all be archived for later analysis. This project will focus on recording/ monitoring bellows from male koalas at a regional scale for the north-east forests. This will be achieved by monitoring occupancy across at least 60 sites per year across ~1.66 million hectares of modelled koala habitat of the north-east forests and analysing the data in an occupancy-modelling framework. It will also be supplemented by the development of a female koala recogniser that will be used to supplement the main analysis (noting females do not call to advertise themselves like males). These surveys follow a standard approach in ecology where occupancy is assumed to be related to meta-population dynamics when a large number of sites are surveyed.

McKenzie et al. (2003)[14] state:

"Estimating the proportion of sites occupied by a target species is important in both long-term monitoring programs and metapopulation studies. In a monitoring context, site occupancy probabilities may be used as a metric reflecting the current state of the population."

Previously, Law et al. (2018)[15] found that on average 64 % of sites in the north-east forests were occupied (more at low elevation and less at high elevation), indicating the presence of a widespread population. Forest harvesting treatment and land tenure (National Park versus State forest) had no effect on occupancy.

Occupancy across many sites is an appropriate surrogate for population assessment at landscape scales when density is low as is expected for koalas. For example, each SM4 song meter samples an area of 300 m radius (~28ha) of forest for koalas and given male koala density in better quality forests of north-east NSW is 0.03 per ha, then just a single male would be expected in the acoustic sample area where a bellow was recorded. Thus occupancy rather than density is likely to be more efficient for koalas at a landscape scale.

Building on our existing koala monitoring data-set, encompassing 2015-2018, this project is uniquely placed to provide a rapid assessment of trends in koala occupancy. Importantly, the opportunity exists to consider the effects of wildfire on koalas from monitoring sites that were burnt in 2019 as well as a paired array of Song Meters at Bellangary and Bril Bril State Forests where one array was burnt and the other was unburnt (these sites were sampled pre-wildfire in 2018).

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[14] MacKenzie, D., Nichols, J., Hines, J., Knutson, M., & Franklin, A. (2003). Estimating Site Occupancy, Colonization, and Local Extinction When a Species Is Detected Imperfectly. *Ecology*, vol. 84, no. 8: 2200–2207. *JSTOR*, ww.jstor.org/stable/3450043.
[15] Ibid.

The use of song meters for this project is complementary to site-based arrays of song meters that DPI will use to estimate koala density before and after regeneration harvesting in a separate project being overseen by the NRC.