182 Understanding the impacts of road and aircraft noise on avian species richness in Milford Sound, Fiordland National Park, New Zealand: A proposed methodology

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Background

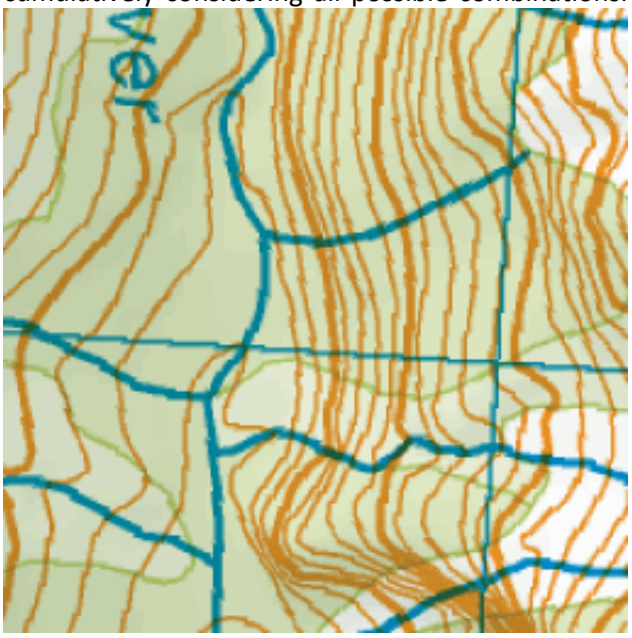
Milford Sound is a tourism hotspot located in the protected natural area of Fiordland National Park, New Zealand. Due to its wild landscape, unique views and natural quietness, it is considered one of New Zealand's must visit locations for tourists, both national and international. Consequently it received nearly 1 million visitors annually pre-Covid, which is of concern because a number of international studies have shown a link between high visitor numbers and degradation of natural soundscapes. Due to the extreme topography of the park, Milford is quite isolated and only accessible by aircraft and a single road; the Milford Highway. These modes of transport generate a disturbance, not only along the highway corridor, but spatially more expansive due to the nature of aircraft and traffic noise propagation - exacerbated by the topography. Whilst effects of these noise sources on human perceived tranquillity in New Zealand have been and are currently being investigated, no such research has focussed on the impacts to wildlife in this context. Similar studies have been conducted internationally, such as in the United States, that conclude anthropogenic noise has detrimental effects on avian wildlife, such as communication, use of space, reduced reproductive success, and altered species richness. Further to this body of work, our research will focus on the impacts of such noise sources on avian species richness in the New Zealand context, which has been identified as a research gap. This research is imperative due to the unique ecology of New Zealand for which more than 70% of bird and animal species are endemic.

Method

Our proposed research will partly follow Sordello et al.'s (2020) systematic map that identifies a number of relevant research papers that will help guide our literature review and research methodology. From here we will establish three research questions that address the overarching aim, such as:

1. What is the spatial extent of anthropogenic noise in and around Milford Sound? With focus on road traffic, aircraft and watercraft noise.
2. Is there an efficient method for autonomous collection of sound recordings for quantification and identification of bird species and the selected anthropogenic noise sources?
3. Is indigenous bird species richness degraded by anthropogenic noise?

In order to obtain answers to these questions it will be necessary to carry out fieldwork in Milford Sound during which collection of sound recordings of the anthropogenic noise sources and bird vocalisations will take place. Firstly, we hope to record aircraft noise, traffic noise and watercraft noise using Wildlife Acoustics Inc.'s type 4 Song Meters. This data will then be mapped using a program such as Noise Model Simulation (NMSim) or NMSim GIS - which is part of the Sound Mapping Tools ArcGIS toolbox. Resultant maps will be used to create a visual representation of each noise source's spatial extent, potentially both individually and cumulatively considering all possible combinations.



To address question two we are developing autonomous acoustic data-logging stations based on the type 4 Song Meters. These will be

deployed as arrays in areas where the Department of Conservation (DoC) has collected data on vegetation and avian species present -referred to as Tier-1 data. Tier-1 data consists of acoustic and observational recording of birds present, along with detailed data on vegetation and invasive animal species. Data was first collected in late 2011 and each year a random sample of 260 sites are measured resulting in each site being recorded once every five years. The acoustic data is from five microphones, one located at the centre of a 20 meter square vegetation plot with the other four located at the end of 200m transect lines each extending out diagonally at 45°. These sample plots are roughly 8km apart and there are about 1350 of them throughout New Zealand (Department of Conservation). We will review the DoC Tier-1 data available on avian species richness for Milford Sound for comparison with our own field study results

At this stage we are unsure as to whether analysis software will need to be developed to recognise anthropogenic noise or whether existing bird-call recognition software, that has machine learning capability, can be 'taught' to recognise anthropogenic sounds that include noise from aircraft, traffic and watercraft. We may also need to identify the sound of other human activity, such as walkers and our own team setting up the equipment in order to disregard these noise sources from our analysis.

Lastly, to address question three, an experimental study is likely necessary in order to draw any decisive conclusions about a cause-and-effect relationship. This will involve playing recordings of the anthropogenic noise sources and then recording the results with our acoustic array. Our study will also include comparisons with a control site in a similar but more remote location where there is no detectable anthropogenic sound. The objective of this review will be to identify any links between the incidence of anthropogenic noise and species richness, ranking contributing noise sources. Determining suitable metrics for analysis of the various sounds as well as defining limits and exposure times will be part of the study.

References

Department of Conservation. (n.d.). Field protocols for Tier 1 monitoring - invasive mammal, bird, bat, RECCE surveys. Retrieved from **https://www.doc.govt.nz/globalassets/documents/our-work/monitoring/field-protocols-tier-1-monitoring-recce-surveys.pdf**. Sordello, R., Ratel, O., De Lachapelle, F., Leger, C., Dambry, A., & Vanpeene, S. (2020). Evidence of the impact of noise pollution on biodiversity: a systematic map. Environmental Evidence, 9(20).