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Sound Decisions: Moving forward with Acoustics

The sounds of electric ferries

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ABSTRACT

Biological and anthropogenic sounds can dominate estuarine and riverine soundscapes, with the latter often impacting the presence and behaviour of the former. As a result, to reduce anthropogenic noise, there is an increasing push to use alternative methods of propulsion, such as electric powered vessels, once more common in their golden age (roughly 1880-1920) before petrol- and diesel-powered motors became dominant. Two 10-m solar-electric vessels operated in the Swan River, Western Australia, provide one example of this alternative. Here, passive acoustic sensor moorings were deployed to the riverbed, to map the local soundscapes, including sounds of passing vessels. At two sites, a 100-m wide passage north of Heirisson Island, Perth, and a broader area to the island's east, numerous vessels were recorded passing near or directly above an OceanInstruments' ST300STD SoundTraps. The electric ferries displayed significantly lower acoustic energy, particularly in lower frequencies, compared with petrol and diesel-powered vessels.

1 INTRODUCTION

Sound is the predominant sensory modality in the aquatic world, used by almost all fauna, in many vital life functions. Anthropogenic noise is recognised as both an acute and chronic stressor, directly or indirectly impacting all fauna, thus the push to minimise its production is growing. Electric motor vessels were developed in Russia and Britain in the mid-1800s and experienced broad use until the 1920s with the advent of the internal combustion engine. Anthropogenic activities and therefore the number and use of these noisier petrol and diesel-powered engines have now become the most common aquatic propulsion system around the world, and continue to rise (Frisk, 2012). While significant information is available on reducing chemical pollution using electric vessels, there is comparatively little data on their underwater sound production, particularly smaller vessels.

Commercial use of electric motors is increasing, particularly with advances in solar-power technology that can reduce the range limitation from power storage. But what potential is there for a wide-scale re-emergence of this application to make a discernible difference to the soundscapes of rivers and estuaries? Soundscapes of rivers and estuaries, such as the Swan and Canning River system, Western Australia, contain numerous biological (Parsons et al., 2013, Marley et al., 2017, Erbe et al., 2016, 2017a), anthropogenic (Marley et al., 2017, Erbe et al., 2013, 2017b, 2018) and geophysical (e.g. wind driven waves and rain) sources. In the Swan River, the Little Ferry Company provides an example, routinely operating two vessels between Elizabeth Quay and Claisebrook Cove (≈5 km), Perth, several times each day. The objective of this study was to characterise the spectral signature of the electric ferry in the shallow waters (3-4 m depth) of the Swan River.

2 METHODS

The ≈72 km-long Swan River is used by a many commercial and recreational vessels, leading to significant differences in the soundscapes around the river (Marley et al., 2017). At various points, the river narrows from broad open waters to channels, tens of metres in width, often including 5 or 8 knot speed limits, which minimises the variability in location and speed of transiting vessels. Two OceanInstruments (New Zealand) SoundTraps (ST300STD) were deployed (≈15 cm above the silt/mud riverbed) in the 2016 and 2017-18 Austral summers, to the north and east of Heirisson Island (henceforth referred to as NH and EH sites), where the river is 120 and 900 m wide, respectively. The SoundTraps were scheduled to record either continuously (2016) or for two of every four minutes (2017-18) at sampling rates of 32 (2016) or 48 (2017-18) ksps.

Visual confirmation of signal sources and vessel routes was conducted on the 10th and 11th February, 2018, from the northern bank of Heirisson Island, and vessel speed confirmed by timing vessel transits between a bridge to the west and a channel marker to the east (350 m). It was assumed that the vessels maintained their speed as they travelled along the vessel channel, past EH (≈100 m closest point of approach, CPA). Where visual confirmation was not available, ferry timetables, consistency of vessel signal time over multiple days, similarities of spectral content of recorded signal, and consultation with the operator were used to confirm the vessel source.

SoundTrap datasets were processed and recording clips of the Little Ferry Co. (electric) and Captain Cook Cruises (combustion) ferries were extracted with a Matlab v2014 user interface designed for analysis of underwater passive acoustic recordings, CHORUS (Gavrilov and Parsons, 2014) and purpose written functions. Broadband sound pressure levels for each pass were calculated in 1-s windows and the 1-s window with the greatest acoustic energy was deemed to correspond to the vessel's CPA. For each passing vessel, the respective 1-s CPA was Fourier-transformed in 0.25-s windows (75% overlap) to provide the power spectral density (PSD) deemed representative of the vessel source signature. Ambient noise samples were identified and analysed for periods (minimal 500 points) before and after the vessel pass and the same procedure applied. Percentiles of PSD were then computed for ambient noise and the CPA of the two types of vessel.

3 RESULTS

In total, 43 (2016) and 17 (2017) Little Ferry Co. and 10 (2016) and 8 (2017) Captain Cook Cruises passes were analysed at the NH site. At the EH site, 18 (2016) and 2 (2017) Little Ferry Co. and 0 (2016) and 3 (2017) Captain Cook Cruises passes were analysed. In all recordings, the electric vessel displayed less broadband energy than the combustion engine ferry. While some energy was present in the electric ferry recordings there was a marked difference between the two vessel types in the lower frequencies (e.g. Figure 1). This characteristic was more evident in the closer range recordings of the NH site.

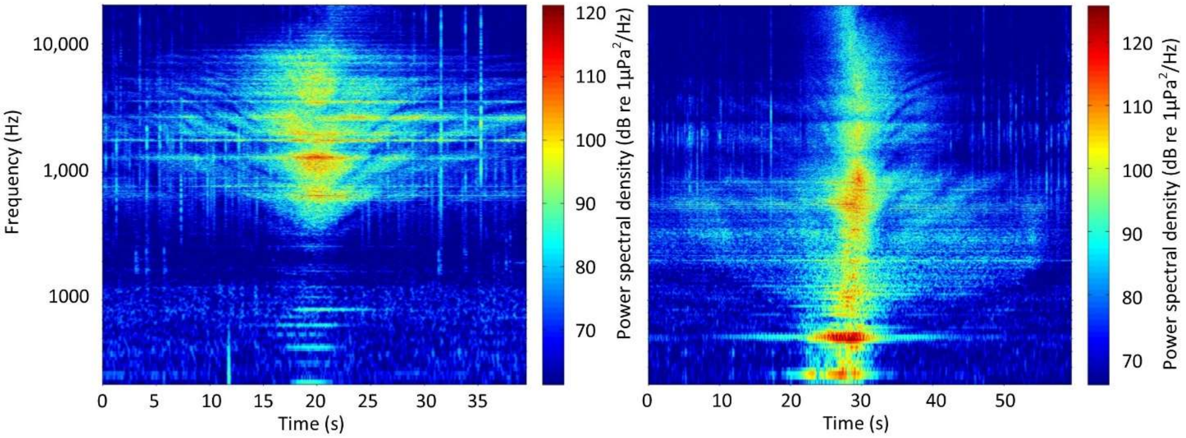

Figure 1: Spectrogram of the electric ferry (left) and Captain Cook diesel powered ferry (right) passing above the North Heirisson SoundTrap site with a closest point of approach at a range of 4 m.

4 CONCLUSION

This study has added to the limited library of information on acoustic (pressure) signatures of small electric vessels and their contribution to underwater soundscapes, particularly in comparison with combustion engine vessels. Broadband levels, and particularly low-frequency energy lower in the recordings of the electric ferry. This difference in spectral content could reduce the impact chronic vessel noise has on marine fauna, particularly those which specialise in low-frequency sound production or reception. Broadscale use of electric motors could have profound effects, not only in the open oceans, but across small water bodies as well. As chronic noise has been recognised as a significant stressor on marine fauna, impact assessments of anthropogenic noise are increasingly evaluating long-term, cumulative effects of persistent low-intensity sources. While the data here clearly show a marked reduction in low-frequency energy, there is a paucity of information to determine by how much this may reduce the impact of chronic vessel noise on marine fauna. Future controlled-exposure behavioural studies could quantify the level of benefit electric motors may achieve, while long-term passive acoustic monitoring would observe the return from anthropogenic to biologically-driven soundscapes.

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