Coastal Dolphins and Noisy Environments

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1. Background

- The **most ubiquitous source of anthropogenic ocean noise is from motorised vessels** – from large commercial container ships to small recreational dinghies[1]
- **Coastal dolphins are particularly vulnerable to underwater noise** due to elaborate acoustic specialisations and high degree of habitat overlap with human activities[2]
- Previous studies suggest **underwater noise can have a range of effects on dolphins**, including: behavioural changes; avoidance; masking; hearing impairment; and physiological effects[3].

Aim: To characterise the marine soundscape and examine the behavioural and acoustical responses of coastal dolphins to 'noisy' environments.

2. Methods

The **Swan-Canning River system in Western Australia** flows through a city with over 1.4 million inhabitants and is **regularly used for human activities**[4-6]. It is also a home to a **resident community of Indo-Pacific bottlenose dolphins** *(Tursiops aduncus)*, which show daily use of the river system and high site-fidelity[7].

Figure 1 The study site was located in the Swan-Canning River, which flows through the Western Australian state capital of Perth.
Red dots (●) indicate the five acoustic monitoring sites.
Visual observations were undertaken at two of these sites: the Fremantle Inner Harbour and Perth Waters.

Acoustic Monitoring

- **Acoustic loggers were deployed at five sites** of high use by dolphins and humans (**Fig. 1**).
- Acoustic data were analysed via **weekly spectrograms** (**Fig. 2**)**, PSD percentile plots, octave-band levels, and GEEs.**

Visual Monitoring

- **A theodolite was used to track dolphins and vessels** at two sites.
- Visual data was **visualised in Vadar**[8] (**Fig. 2**), then **analysed using GAMs.**

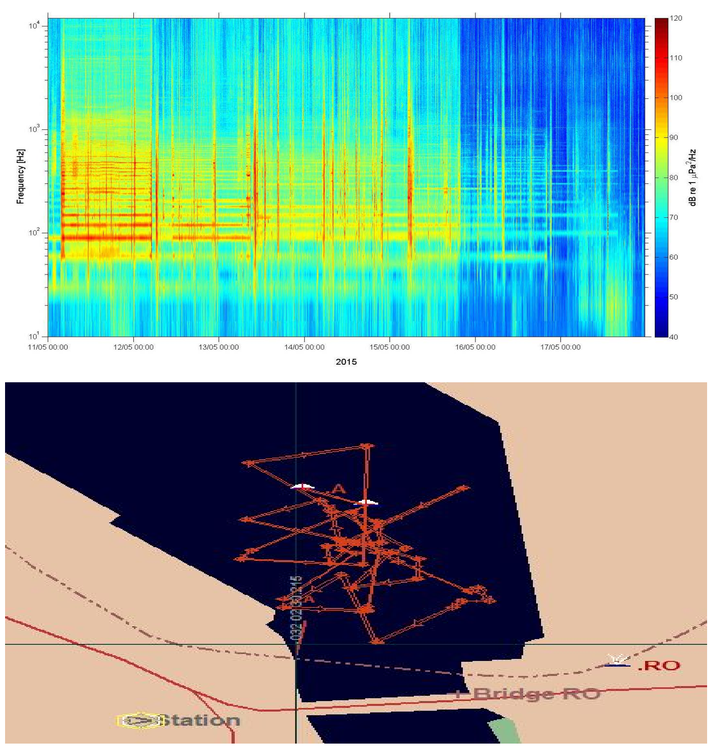

Figure 2 A combination of acoustic and visual survey techniques were used: a) autonomous underwater loggers to collect acoustic data; b) weekly spectrograms to identify prominent sound sources; c) a surveyors theodolite to track dolphins and vessels; d) the software Vadar for recording occurrence, movement patterns, and behaviour of tracked objects.

3. Results and Discussion

Over **15,000 h of acoustic data** and **300 h of visual data** were analysed in this study.

Sound Sources

- **Abiotic, biotic and anthropogenic sound sources were recorded** (**Fig. 3a**).
- **Anthropogenic noise patterns existed which mimicked human behaviours** – at one site, vessel traffic was present in 52% of hourly recordings, showed peaks in the early morning and late afternoon, and was particularly prominent on weekends (**Fig. 3b**).

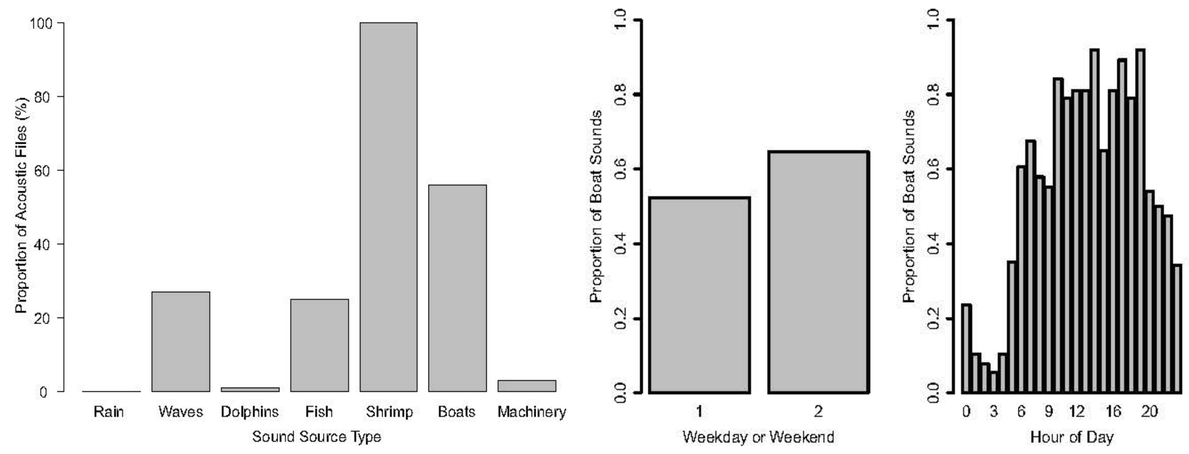

Figure 3 Hourly acoustic recordings across a 6 week period at Perth Waters revealed a) a number of sound sources which contributed to the soundscape, and b) patterns of vessel traffic noise.

Soundscape Variability

- **Temporal variation existed within sites**, with the soundscape varying by hour of day, day type (weekday vs weekend), and between deployments.
- Each site also had a characteristic soundscape, highlighting **spatial variation between sites**.

Dolphin Occurrence

- **Dolphins exhibited differential site use** within the Swan River, despite both areas having high levels of vessel traffic.
- **At the preferred site occurrence was related to environmental conditions**. This may reflect the importance of the Fremantle Inner Harbour as a foraging hotspot.
- Therefore, **some busy, noisy environments are worth staying in** – but more subtle behavioural responses or strategies may exist to help cope with such environments.

4. Conclusions

- **Marine soundscapes show high variability**, both temporally and spatially, even within the same system.
- **Vessel traffic exists at high levels in the Swan River** and may have the potential to influence the behaviour of dolphins utilising this system.
- **Dolphins show differential habitat use** within the Swan River, and **may remain present in important sites despite high levels of vessel traffic.**
- **Further research is required** to study dolphin foraging within the Swan River and to investigate the existence of fine-scale behavioural or acoustical responses to human activities and noise.

Conclusion: This study emphasises the need to consider context in behavioural response studies, in terms of the habitat studied, explanatory variables considered, and response variables selected.

Literature:
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