MAPPING UNDERWATER AMBIENT NOISE IN THE SOUND OF ISLAY TIDAL-STREAM FLOW: A POTENTIAL TIDAL ENERGY EXTRACTION AREA

C Carter Scottish Association for Marine Science, Oban, UK
B Wilson Scottish Association for Marine Science, Oban, UK

1 INTRODUCTION

The deployment of marine renewable devices in the UK coastal waters is expected to accelerate in the near future due to the abundance of wave and tidal-stream resource and the current positive political will. The environmental impact of these deployments is poorly understood as areas suitable for energy extraction are typically challenging to assess. This study is the initial stage of an investigation into the acoustic interaction between emerging tidal-stream devices and marine mammals. Whilst there is much data regarding ambient noise in deep water, there is little information describing shallow water tidal-stream areas. This study measured the ambient noise levels in the Sound of Islay on the west coast of Scotland using four drifting hydrophones.

2 METHODS

2.1 Study Site

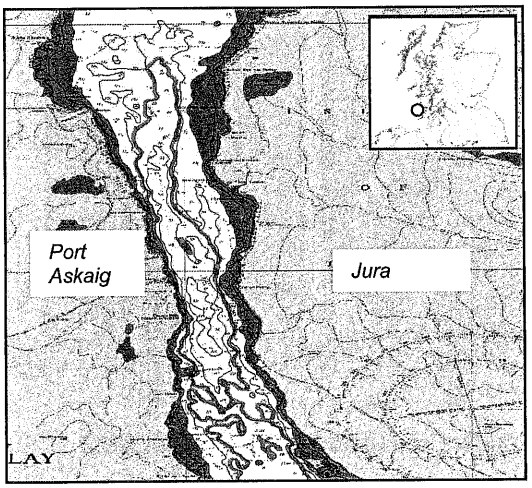

Figure 1. Sound of Islay study site.

The sound of Islay is a narrow strait between the islands of Islay and Jura on the west coast of Scotland (Figure 1). The narrowest section of the Sound is approximately 11 km long by 1 km wide. This is an area of interest to the renewable industry; consent has been obtained by Scottish Power Renewables to deploy ten tidal-stream turbines in an area just south of Port Askaig. The aim of this study was to investigate underwater background sound in coastal tidal habitats, measure and map the background sound levels in the Sound of Islay prior to tidal-stream device deployment.

2.2 Survey and Analysis

The survey was conducted in September 2009 between the latitudes 55° 53' N and 55° 48N using the drifting 'ears' methodology[1]. Drifts were conducted on both ebb and flood tides and at a range of tidal flow speeds. Weather conditions during this period were good, it was sunny to light cloud, the wind was slight to moderate and the sea state was 0-1 occasionally 3. Timing of drifts were conducted were possible when there was least shipping/boat traffic.

Each drifter recorded a continuum of data, therefore to avoid psuedoreplication sample points were selected to ensure separation both in space and time by subdivided the area into 60 lines of latitude. Sample segments (60 second duration) from the sound files were then extracted by location (Figure 3). Each file was checked for contamination visually and aurally before processing. Broadband sound pressure levels (frequencies up to 40 kHz) were calculated using;

$$\mathbf{SPL = 20*log_{10}(P_{rms}/P_{ref})\ dB\ re\ 1\ \mu Pa}$$

The SPL values used to map the survey area were calculated using Matlab© for four broadband frequency ranges; the complete frequency range recorded (no filtering) and three filtered categories (up to 1 kHz; 1 - 10 kHz; greater than 10 kHz). These sound levels were then contour mapped in ArcGIS using ordinary krigging, a spherical semivariogram and a variable search radius.

3 RESULTS

A total of 30 files were obtained equating to 15.5 hours of underwater recording. From these files 596 segments were analysed. The data were grouped into four categories; flood, ebb, flow speed greater than and less than 2 m/s (Figure 2).

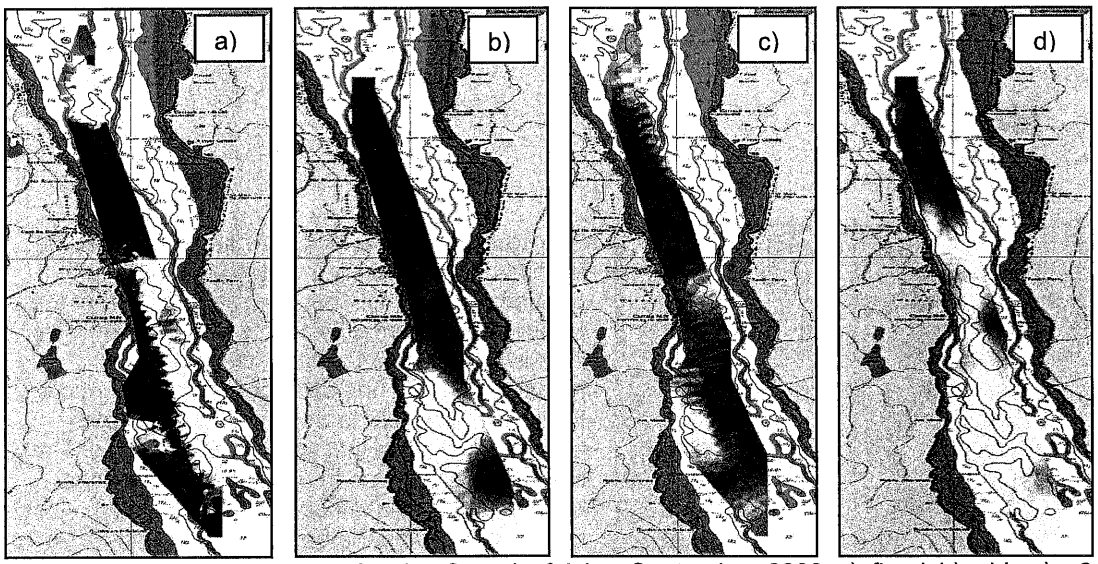

Figure 2. Soundscape maps for the Sound of Islay September 2009 a) flood b) ebb c) >2m/s d) <2m/s

The SPL's measured ranged from 81 to 128 dB re 1µPa (dark colours denote the higher SPL).

Figure 3 illustrates the 'greater than 2m/s' data set further filtered into the three broadband categories.

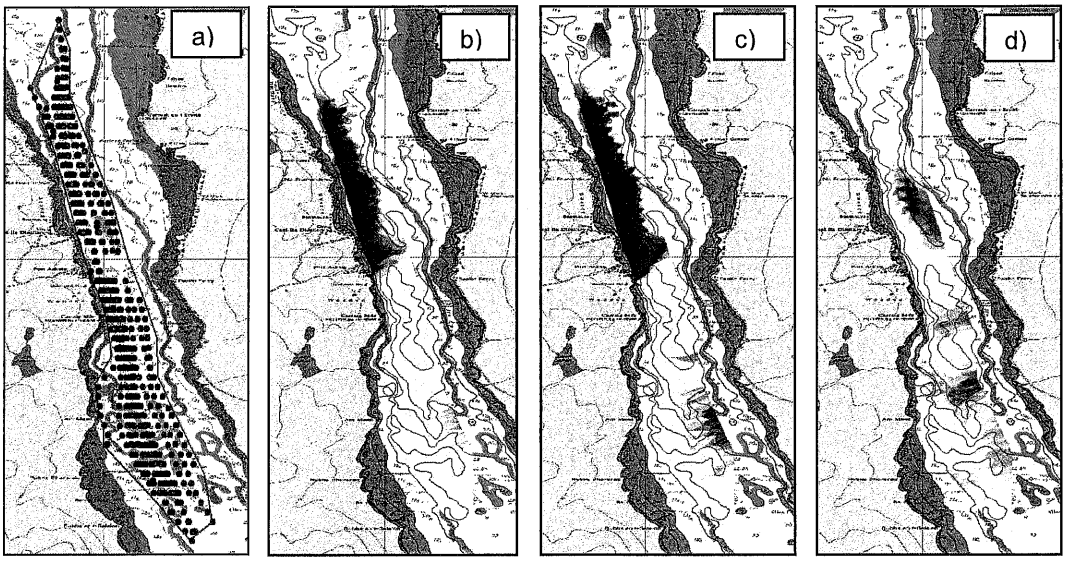

Figure 3. Map a) Locations of all sample points analysed. Maps b) c) & d) 'Flow speed greater than 2 m/s' soundscape maps in the broadband filters of b) <1 kHz c) 1-10 kHz and d) > 10 kHz

4 DISCUSSION

The soundscape maps reveal patchiness in the ambient noise levels within the Sound of Islay. The variability of ambient noise in shallow areas is well understood, but these maps are the first visual representation of this variability.

The pattern of sound intensity differed between flood and ebb tidal directions and on comparison of the two tidal flow speed categories the sound levels appear to be higher with the increase flow levels. Figure 3 suggests that the greatest sound energy in this area at this time was within the middle broadband category.

This project is the initial stage of a larger investigation, and further work will include investigations into the patterns observed and to assess temporal and geographical variations. A model will be generated that will consider the sound signal from tidal-stream devices in context of the ambient noise characteristics measured, with the aim of developing an informed estimate of potential acoustic detection distance. Ultimately this will lead to a synthesis of results to inform the debate regarding the acoustic detection distances and collision risks to marine mammals.

5 ACKNOWLEDGEMENTS

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6 REFERENCES

1. B Wilson, C Carter and J Norris. Going with the flow: A method to measure and map underwater sound in tidal-stream energy sites. Proceedings of IOA this issue.