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Listening for canaries in a tornado: Acoustic monitoring for Harbour porpoise at the FORCE site.

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INTRODUCTION

The FORCE site in Minas Passage, Bay of Fundy, has tidal ranges of over 13 m and current velocities that regularly exceed 3 m/s. This makes it an attractive site for generating electricity from tidal turbine devices, but also a very challenging site from both an engineering and environmental monitoring perspective. However, with proper study design and analytical techniques, environmental monitoring can be successfully achieved. The aim of this study was to determine baseline Harbour porpoise habitat use in Minas Passage.

METHODS

In this study we used a gradient design of seven C-POD passive acoustic devices to collect data on porpoise during this two year study. The C-POD devices were deployed several times during the year at depths ranging from 27 to 84 m using an Open Sea Instrumentation SUB buoy, an acoustic release and weights. Data were collected from May to November in 2011 and 2012. After retrieval, click detections were run through the classifier in CPOD.exe V2. Data were exported in 10 minute periods so that tidal covariates would be relatively constant. A GAM/GEE statistical model was used to explore the relationship between porpoise presence and a number of environmental and study covariates. The GEE construct was necessary to control for the temporal autocorrelation in the porpoise detection data which lasted up to 120 minutes in our data.

RESULTS

Combined, the seven C-POD units monitored for a total of 1,342 days. Of the 397 unique days monitored during this study, only eight had no porpoise detections at any of the seven locations. While porpoise were present in Minas Passage on almost every day, they were present on average only 0.56% of the minutes in a day. As might be expected from a largely seasonal population, time of year was the most important factor in predicting porpoise presence in Minas Passage with peaks in the spring and fall (Figure 1).

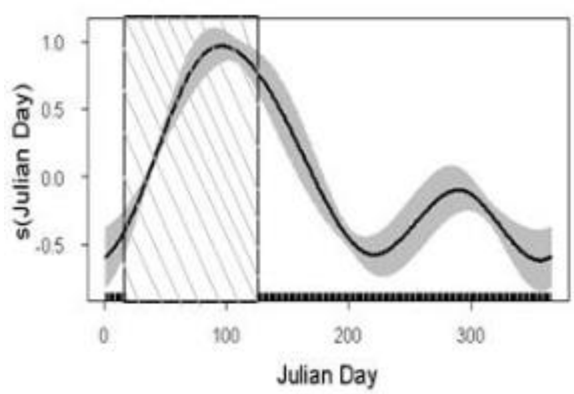

Figure 1 GAM plot of the relationship between Julian Day and porpoise detections. Grey areas indicate 95% CI. Cross hatched area is to indicate time period without data but across which the GAM has extrapolated this relationship.

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The tidal covariates of velocity and height were the next most important covariates in predicting porpoise presence. Porpoise presence peaks in Minas Passage during moderate flood tides (Figure 2) and during moderately high tides (Figure 3). The location of the C-POD (likely due to the water depth) and time of day also played a significant role in predicting porpoise presence, with more detections at deeper locations and during the night.

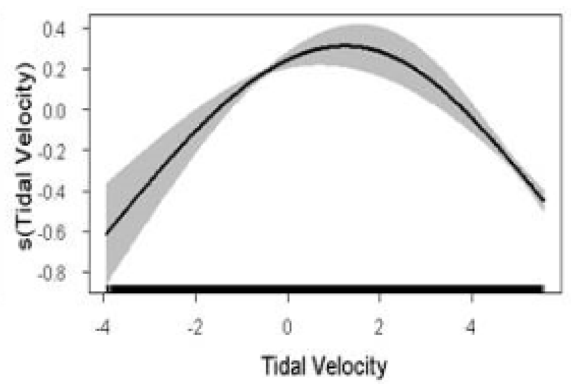

Figure 2 GAM plot of the relationship between Tidal Velocity (m/s) and porpoise presence. Grey areas indicate 95% CI. Positive velocity indicates a flood tide. Negative velocity indicates an ebb tide.

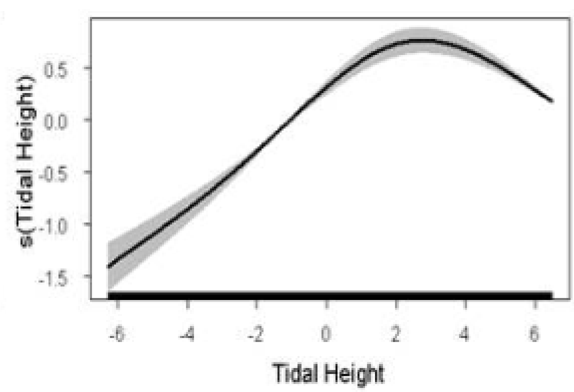

Figure 3 GAM plot of the relationship between Tidal Height (m) and porpoise presence. Grey areas indicate 95% CI.

The extreme water flow at tidal turbine sites poses a large challenge for monitoring with passive acoustics as the tidal flow causes flow noise on hydrophones and generates bedload transport noise by moving cobble and other material through the site. Bedload noise is detected as clicks by the C-POD unit, and because the units limit the number of clicks they will record in a minute, bedload noise can cause severe memory saturation, whereby the unit stops recording clicks for that minute. It is therefore important to incorporate this into the statistical model and to avoid locations with large bedload noise. We found that locations ~700 m apart could have drastically different bedload noise regimes. We therefore suggest that preliminary deployments be conducted at different locations during extreme tides to identify and avoid those locations with excessive bedload noise.

CONCLUSIONS

In conclusion, Harbour porpoise use of Minas Passage is driven by a number of factors, but especially by tidal variables. When porpoise are present in the northern reaches of the Bay of Fundy, they tend to use Minas Passage during fairly dynamic periods of tidal exchange, suggesting that this is when conditions are optimum for foraging. That fact porpoise are not detected equally across comparable flood and ebb velocities suggests that foraging conditions vary across these tidal states. This may be due to differences in whether the water is coming from the outer Bay of Fundy or from the inner Minas Basin. It could also be due to bathymetric effects which result in flow dynamics (such as upwelling) which cause prey concentrations on moderate flood but not ebb tides.

ACKNOWLEDGEMNTS

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