ASSESSING THE PERFORMANCE OF TWO PASSIVE ACOUSTIC MONITORING TECHNOLOGIES FOR PORPOISE DETECTION IN A HIGH FLOW TIDAL SITE

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1   Introduction

Current interests in harnessing tidal energy from Minas Passage, a high flow channel in the upper Bay of Fundy, require examination of potential effects of tidal turbines on the environment, including impacts on commonly occurring harbour porpoise, *Phocoena phocoena* (Linnaeus, 1758). To collect baseline data on porpoise presence in the Fundy Ocean Research Centre for Energy (FORCE) turbine test site in Minas Passage, two Passive Acoustic Monitoring (PAM) technologies were used: the C-POD (continuous porpoise click logger, Chelonia Ltd) and the icListenHF (digital hydrophone, Ocean Sonics Ltd) (Figure 1).

Prior multi-year PAM studies in the Minas Passage involved C-POD hydrophones housed within streamlined SUB buoys suspended 3 m above the seafloor [3][4]. During high flows, these SUB buoys experienced high variability in tilt [3]. In addition, high-flow induced noise in the Minas Passage exceeded the C-POD's maximum recordable clicks per minute, resulting in "lost time", and thus under-detected porpoise click trains. To increase detection efficiency, a new mooring design and acoustic shrouds were tested.

2   Methods

2.1   Description of Study Area

The FORCE test site, located in Minas Passage, NS, is 5-6 km wide and 13 km long and features semidiurnal tides with a maximum tidal range of >13 m [2]. During spring tides, current speeds can exceed 6 m/s at the surface and be as high as 3 m/s at 3 m above the bottom [2].

2.2   Instrument Platform

A bottom moored instrument platform was deployed within the FORCE Crown Lease Area on 5 June 2014 and recovered from Minas Passage on 2 July 2014. The platform housed an acoustic release, two tilt loggers, two icListenHFs (one bare, one shrouded with 1.27 cm, 20 ppi open cell foam), two C-PODs and approximately 400 kg of anchor weight. The sensors were located about 1 m off the seafloor, within the boundary layer where current speeds are reduced (<1 m/s). The acoustic release was triggered during recovery of the unit. One C-POD, housed in a tethered SUB buoy, was located within 50 m of the platform.

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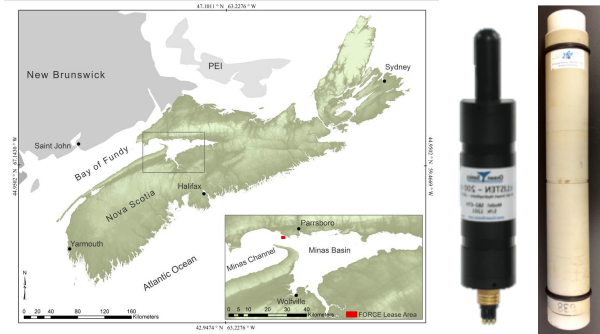
Figure 1: Left: Map of the Bay of Fundy including the location of the FORCE Crown Lease Area (red box) in Minas Passage, Nova Scotia. Right: icListenHF and C-POD hydrophones, not to scale.

3   Results

3.1   C-POD and icListenHF Performance

The platform mounted C-PODs detected greater numbers of click trains and greater detection positive minutes (DPM/day) compared to the C-POD housed in a SUB buoy (Figure 2). Platform mounted C-PODs 639 and 1615 showed similar detection peaks in early June after which C-POD 1615 became detached from the platform.
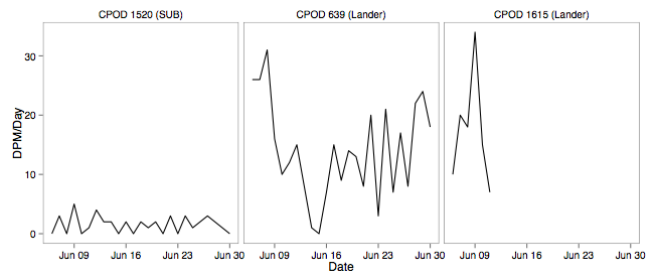
Figure 2: DPM/Day of SUB buoy mounted C-POD 1520 and platform mounted C-PODs 639 and 1615 (detached on 12 June).

Harbour porpoise detections recorded by a C-POD and icListenHF hydrophone co-located on the instrument platform showed that, over the same time period, the C-POD recorded only 19.9% of the click detections recorded by icListenHF. In marked contrast, the icListenHF recorded 99.8% of all detections recorded by the C-POD (Table 1).

Table 1: Comparison of DPMs recorded by two platform-mounted hydrophones

| Hydrophone	Total DPM	icListenHF DPMs; % Recorded	C-POD DPMs; % Recorded
C-POD 639	205	19.9	-
icListenHF 1239	958	-	99.8

3.2 Time Lost Due to Noise

During flood tides, percent lost time was similar for the SUB buoy C-POD (1520) and platform mounted C-POD (639) (Figure 3). But during the less noisy ebb tide, the platform C-POD showed significantly less lost detection time (Wilcoxon signed rank test, $\alpha = 0.05$, $p < 0.001$).
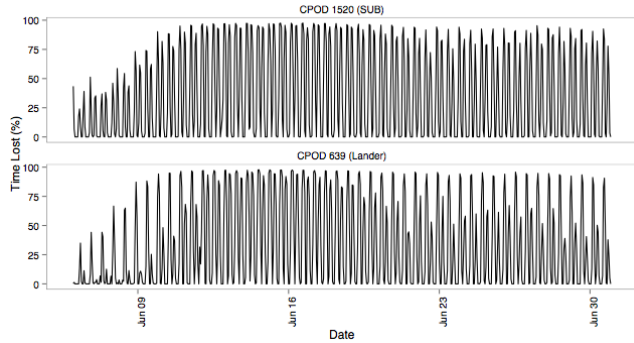
Figure 3: C-POD percent-lost time plots. Top: SUB Buoy mounted C-POD 1520; Bottom: platform mounted C-POD 639. The series of peaks represent the sequence of flood and ebb tides with flood tides showing greater % lost time compared to ebb tides. A spring neap pattern is also evident.

3.3 Shroud Test

Shrouding of one of the two icListenHF hydrophones with acoustic foam (20 ppi, 1.27 cm) reduced flow noise in tank tests but at FORCE, the shrouded hydrophone recorded a similar sound profile to the non-shrouded unit within the porpoise click frequency range of 120-140 kHz (difference was < 3dB). The difference was greatest at high current speeds on the flood tide (Figure 4).
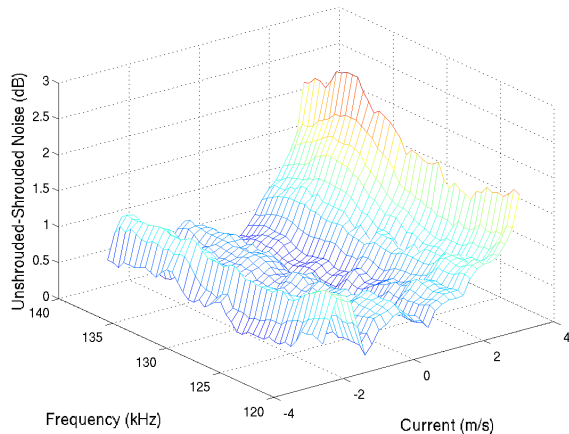
Figure 4: The difference in mean ambient noise (dB re $1\mu Pa^2/Hz$) between shrouded and non-shrouded icListenHF hydrophones. Note that the difference is low overall (mostly <1 dB) and greatest at depth averaged speeds >3 m/s on the flood tide.

4 Discussion

The two mooring types examined (tethered SUB buoy and bottom platform) differed in both mobility and distance from the seafloor, and thus experienced different current regimes. These differences are reflected in percent time lost in C-POD recordings (Figure 2) and in instrument tilt, both of which were lower for C-PODs housed in the bottom-moored platform. The tethered SUB buoy (2-3 m above bottom) experienced extreme changes in tilt, up to 60 degrees, at high flow speeds, potentially increasing the pseudonoise and time lost with C-PODs. Noise generated by shackle and chain movements, vibrations, and strumming probably also increased C-POD percent lost time. The C-PODs mounted on the platform were in a more stable, less noisy environment, and may have had greater porpoise detection range.

A comparison of the performance of both technologies, co-located on the platform, showed that the icListenHF recorded five times the number of C-POD Detection Positive Minutes, in large part due to its greater detection range (distance). The icListenHF does not have a built in setting like the C-PODs "lost time" and will only miss porpoises clicks if the ambient noise is great enough to mask the clicks. This hydrophone can also record raw audio files, which were used to validate the C-POD porpoise clicks.

Although foam shrouding has been shown to reduce noise recorded by hydrophones in the frequency range 0-30 kHz [1], this study did not find a significant reduction in the ambient sound collected at any frequency, most likely due to the extreme flows and thus very noisy conditions of the Minas Passage.

5 Conclusions

Hydrophones deployed on the instrument platform outperformed those housed in SUB buoys. Overall, the icListenHF has greater porpoise detection efficiency than the C-PODs. Shrouding the icListenHF with open cell foam did not have an effect on the ambient noise recorded, however, other shrouding options should be explored.

References

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