Summary Report on Fleet Forces ICEX Acoustic Monitoring

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A Fleet Forces sponsored US Navy ICEX training event took place in the Beaufort Sea north of Alaska in March 2020 (Figure 1). A prototype cryophone (ice-associated microphone) was deployed at the ice camp for research purposes and the recordings were analyzed to determine if marine mammals were present during a portion of this exercise from 04-05 March 2020. Given the location, time of year, and the fact that the ice was fast-packed, the only marine mammal species likely to be present were ringed seals (*Pusa hispida*) (Stirling, Calvert, and Cleator 1983). Ringed seals produce a variety of underwater vocalizations, including barks, yelps, growls, and chirps (Stirling 1973; Jones et al. 2014). These vocalizations are generally short duration (largely less than 0.3 s) and are generally between 100 and 1000 Hz, although can extend over 1000 Hz, particularly in the harmonics of the barks (Stirling 1973; Stirling, Calvert, and Cleator 1983; Jones et al. 2014).

The cryophone had three accelerometers and one hydrophone that was frozen into the ice at a depth of 10 cm (Figure 2). The ice itself was about 1.5 m thick, so the hydrophone was about 1.4 m from the water. The audio jack connecting the two horizontally oriented accelerometers to Channels 3 and 4 slipped out of the socket so what was recorded was from the stereo mic in air and not the accelerometers in the ice. Therefore, only the data from the vertical accelerometer and hydrophone were analyzed for sub-ice underwater vocalizations. The data were analyzed using a program called Triton, developed by Scripps Institution of Oceanography's Whale Acoustics Lab (Wiggins, pers. comm). The data were manually scanned using spectrograms set initially from 0-5 kHz, then 0-1.5 kHz, at a 5000-point FFT with 95% overlap using a hanning window. Both channels (the accelerometer and the hydrophone) were scanned; most sounds did occur on both channels at varying received levels, but occasionally a sound would only be detected on one channel or the other (most often channel 1, the vertical accelerometer). Long term spectral averages (LTSAs) were also created for each file, averaged over 20 Hz and 5 sec and across the full bandwidth of the recording (0 – 22 kHz) in order to view the data holistically. The recordings were all broken into two files, with ~2/3 of the data in the first file and ~1/3 of the data in the second file.

The first recording was started at approximately 0400 UTC 04 March. This recording lasted 3.27 hours, and the dominant underwater noise in this recording is from one of the two Expendable Mobile ASW Training Targets (EMATTs) that were launched just after the recording was started, along with electronic self-noise. The EMATT that activated was programmed to transmit dual tones at around 1.0 and 2.9 kHz for 57 sec, then an LFM sweep (700-1400 Hz) over the next 3 sec, then repeat the 1-minute cycle. The first 15 min are also dominated by manmade sounds (e.g. walking on ice) as the recorder and EMATTs were deployed. These sounds were picked up due to the shallow depth in the ice of the hydrophone; the surface man-made sounds are not likely to transmit far into the water, and all were made relatively close (<100 m) to the cryophone. Furthermore, the sound energy of the EMATTS is propagated mostly through upward-refracting water reflecting off the bottom of the ice, allowing the cryophone to pick up the signal well. The second recording was started at approximately 0400 UTC 5 March and lasted 4.18 hours. There is again considerable man-made noise at the start of this file (e.g. walking, snow mobile), and then electronic self-noise along with a mid-frequency upswept pulse from 2.7 to 3.8 kHz that occurred every 9 – 18 minutes. There were also two or three passing vehicles (e.g. snow mobiles) that are detectable in this file. The third recording was started approximately 1700 UTC 5 March, and lasted only 1.49 hours. This recording was particularly noisy with man-made sounds, including detectable conversation for portions of the recording, along with electronic self-noise. Since these recordings were made at night, all anthropogenic noise was on the surface, and there was little or no in water activity at the time.

In addition to these anthropogenic sounds from the surface, there were a variety of sounds that likely were made by the ice shifting, as well as other sounds that could not be identified but were likely ice-associated, or possibly anthropogenic. There were no clear, distinguishable ringed seal vocalizations, although there were a few very faint sounds that could have been barks or yelps. However, ringed seals typically produced vocalizations in series (Jones et al. 2014), making it unlikely that the occasional faint sounds were actually from ringed seals. All sounds of note were annotated in an excel spreadsheet.

The cryophone proved to be an effective means of monitoring underwater sounds. The EMATTs traveled a distance of 10 nm away and were detected the duration of the recordings; although ringed seal vocalization source levels are likely far lower than the sounds emitted by the EMATTs, this gives some idea of the potential detection radius for the cryophone. The periods when the surface anthropogenic activity is occurring in close proximity to the cryophone are dominated by those broadband noises due to the shallow hydrophone placement in ice (only 10 cm down), and any ringed seal vocalizations that were underwater could have been masked.

Figure 1 – Satellite image of the Beaufort Sea and adjacent Chukchi Sea with the approximate location of the ICEX exercise in March 2020.

Figure 2 - Cryophone embedded in ice.