

Passive Acoustic Monitoring Of Marine Mammals Using Autonomous Surface Vehicles

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C-Worker is a 5.6 m long ASV. It has a displacement of 4.5 t, diesel-electric propulsion, twin propellers and a top speed of 6 kt. C-Worker deployed a 220 m tow cable with an array of two hydrophones and a depth sensor and an external CTD sensor-recorder.

Rationale

Autonomous Surface Vehicles (ASVs) have a number of advantages as platforms for towed-array acoustic surveys for marine mammals, compared to conventional ships:

- Cost - lower vessel running costs and fewer personnel required
- HSE - reduced exposure of survey personnel in remote or exposed locations
- Manoeuvrability – precise control when working in close proximity to animals
- Flexibility - ASVs can be transported and launched from any harbour or from a support platform
- Quieter - smaller vessels with less powerful propulsion systems create less self-noise; they are less likely to disturb target animals or mask their vocalisations.

Summary

The LADC-GEMM project aims to compare the suitability of various passive acoustic monitoring (PAM) platforms for marine mammal surveys of the Gulf of Mexico, to understand impacts of short-term and long-term environmental stresses. This research is supported by a BP/GOMRI Consortium grant.

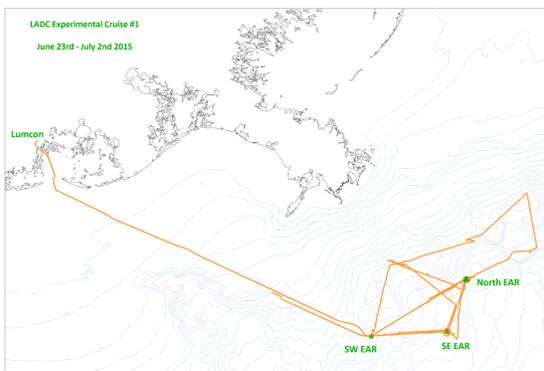
LADC-GEMM Experimental Cruise 1 took place in the northern Gulf of Mexico in June-July 2015. Hydrophone arrays were deployed from two types of 4-6 m ASV. Continuous, wideband sound recordings were made onboard the ASVs using a calibrated PAM system (sampling rate 500 kHz per channel, sample size 16 bit, -3 dB filter pass-band 20-160,000 Hz). The recordings were searched offline for sounds produced by the wide range of cetacean species that inhabit the Gulf, using automatic detectors for tonal sounds, mid-frequency and high frequency click detectors, and manual spectrogram review. Recording effort totalled 225 h (1183 km) over a 10-day period. The ASVs were also equipped with a wireless telemetry link to the support vessel, which enabled the hydrophone signals and processing software to be monitored by a PAM operator in real-time.

Sperm whales were encountered in three regions. Some aggregations were extensive, with continuous acoustic detection for more than 40 km of survey track line near the *Deepwater Horizon* site. Overall, sperm whales were recorded from C-Worker in 15% of 1528 successive 5-min periods of transect and transiting effort. We investigated the use of ASV-derived data for estimating sperm whale density and abundance by Distance Sampling, but concluded that the survey fleet progressed too slowly (~3 kt) relative to the movements of the whales, to consistently localise and extract perpendicular range from the array using Target Motion Analysis. This effect will be addressed in Cruise 2, planned for 2017, which will employ a modified and more powerful version of the C-Worker ASV.

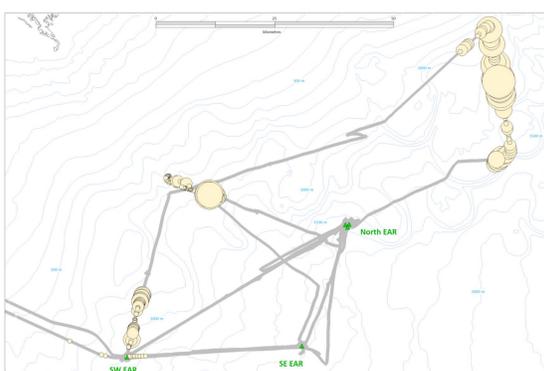
Other cetacean vocalisations detected during Experimental Cruise 1 were the whistles, pulsed calls and echolocation click trains of delphinid species. Detections of delphinids were relatively scarce however, and low intensity, and were mostly recorded whilst the ASVs sailed in holding patterns close to our Environmental Acoustic Recording System (EARS) buoys.



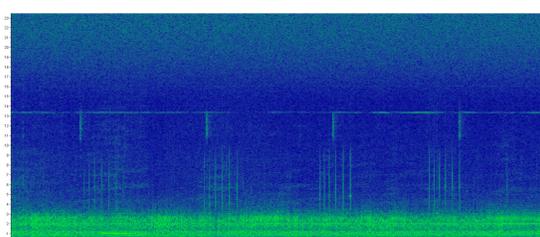
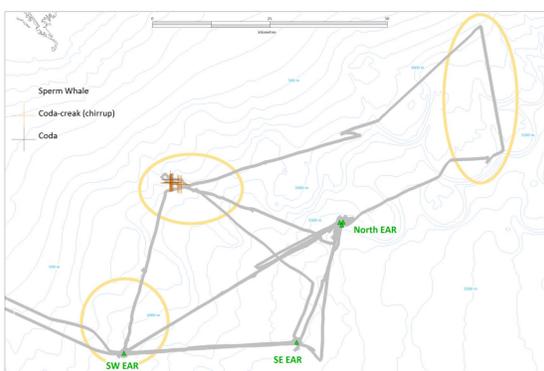
C-Enduro is a 4.2 m catamaran powered using a combination of solar panels, wind turbine and diesel generator, with two electric engines. It has a cruising speed of 3 kt and was designed for deployments of up to 90 day duration. C-Enduro towed a 55 m tow cable, with a single hydrophone.



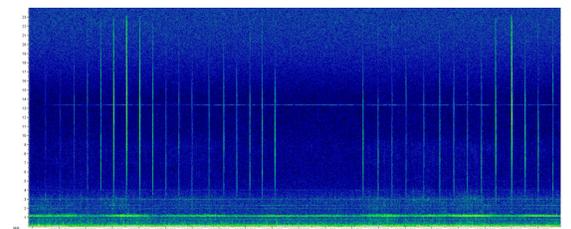
LADC-GEMM Experimental Cruise 1.



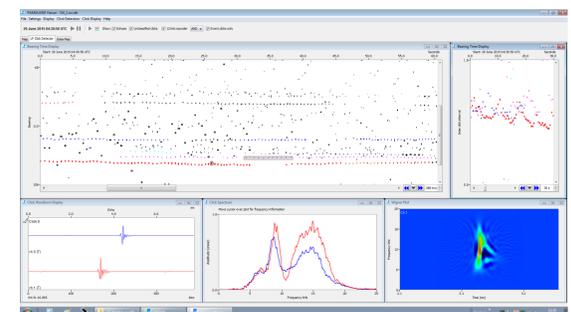
Sperm whales were aggregated in three regions. The diameter of these circles represents the number of vocalising whales (1-7 whales) in successive 5 min periods.



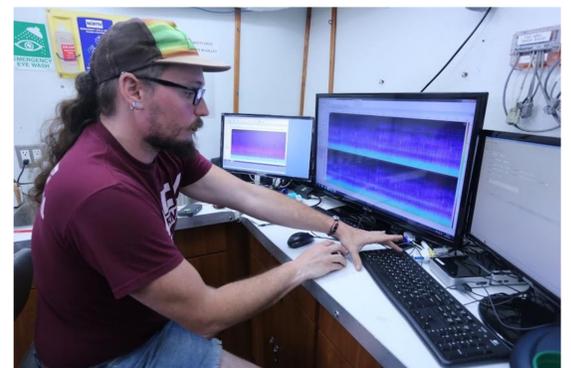
Sperm whale social calls (codas and coda-creaks) were heard in one region only (map above). All other detections were of click trains and creaks associated with foraging. This spectrogram shows a 6-click coda sequence.



Sperm whale click trains visualised in a 0-24 kHz spectrogram (above) and in PAMguard click detector displays (below).



In PAMguard's offline viewer mode, the click train of an individual sperm whale is distinguished from those of other vocal whales and from echoes by its click bearing track, inter-click interval, and short-term consistency of waveform and frequency characteristics.



Real-time monitoring of the ASV-borne PAM systems via a telemetry link on the support vessel *RV Pelican*.



A 4 m ASV recording bottlenose dolphins with a towed hydrophone array during previous deployment trials in Cardigan Bay, U.K.