Use of Passive Acoustic Monitoring to Assess Beaked Whale Distribution and Habitat Use in the Gulf of Alaska

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Background

- In the Gulf of Alaska (GOA), little is known about beaked whale abundance and distribution.
- The 2013 Gulf of Alaska Line Transect Survey (GOALSII) took place in the temporary maritime activities area (144,560 km^2) used by the Navy for training exercises.
- During 23 days of acoustic effort, 456 hours of real-time monitoring was conducted over 6,678 km of trackline.
- The survey was divided into four strata: inshore, offshore, seamount, and slope (**Figure 1**).
- Three species of beaked whales were detected acoustically: Baird's (*Berardius bairdii; n=9)* , Cuvier's (*Ziphius cavirostris; n=34)* and Stejneger's (*Mesoplodon stejnegeri; n=6)* ***(Figure 2).***
- The aim of this study was to examine variation in habitat use by beaked whale species and characterize their echolocation signals.

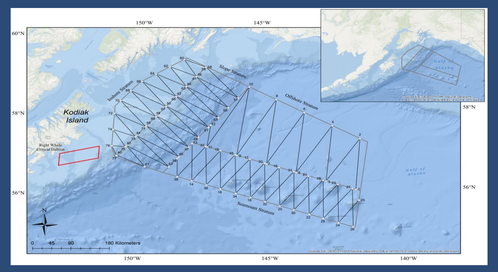


Figure 1. Map of survey area line-transect design

Methods

Data Collection

- A five element towed hydrophone array system.
- Continuous, 24-hour, real-time acoustic monitoring, localization and recording, simultaneous with visual methods.

Post-Processing & Analysis

- Echolocation clicks were characterized using PAMGuard Viewer mode software to measure inter-pulse interval (IPI) and peak frequency.
- 9 acoustic encounters were analyzed: Baird's (n=5), Cuvier's (n=4) and Stejneger's (n=3) beaked whales, for a total of 12 click trains.
- 10-25 clicks/ encounter were measured.
- Click measurements were compared to published results in Baumann-Pickering et al. 2013.

Results

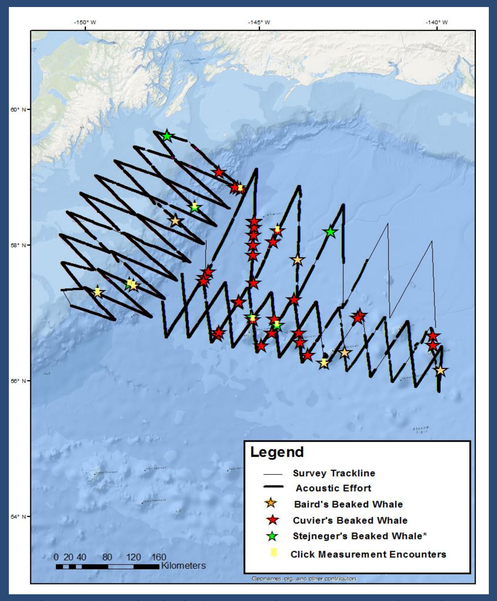


Figure 2. Beaked whale acoustic encounters along the GOALSII survey tracklines

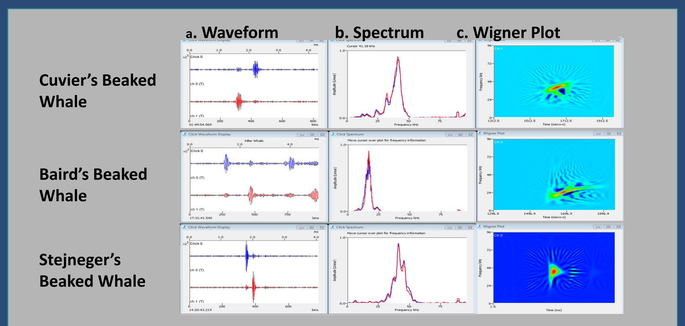


Figure 4. Examples of beaked whale click characteristics in PAMGuard software. The waveform (a), spectrum (b), and wigner plot (c) for three species of beaked whales Cuvier's, Baird's, and Stejneger's beaked whales.

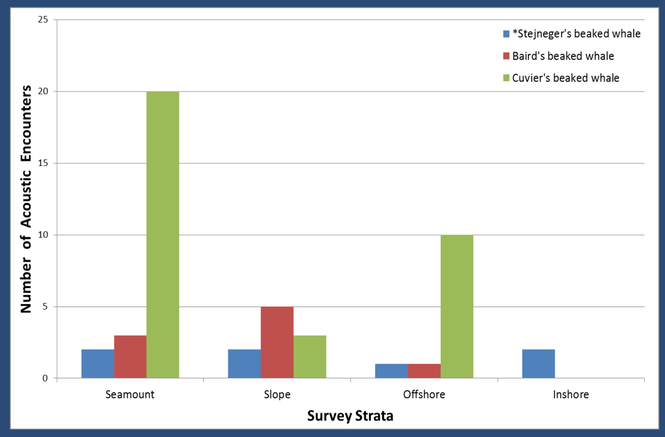


Figure 3. Number of beaked whale encounters within each stratum by species (blue = Stejneger's beaked whale; red = Baird's beaked whale; green = Cuvier's beaked whale).

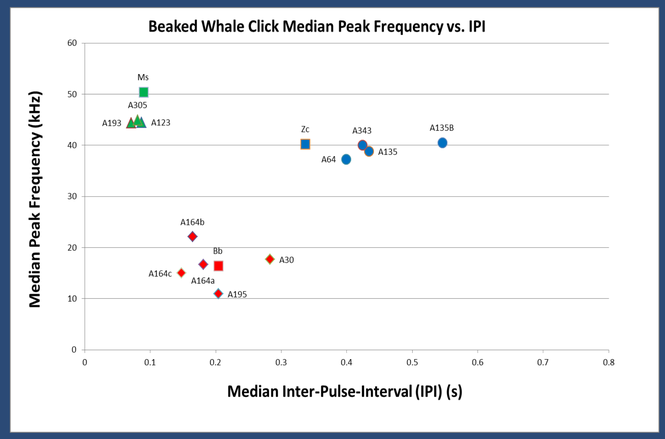


Figure 5. Beaked whale click median peak frequency (y-axis) versus inter-pulse-interval (x-axis) by species (green = Stejneger's beaked whale; red = Baird's beaked whale; blue = Cuvier's beaked whale. Each of the acoustic detection ID's are labeled alpha-numerically. Measurements from published values (Baumann-Pickering et al. 2013) are labeled by species acronym and plotted as square symbols.

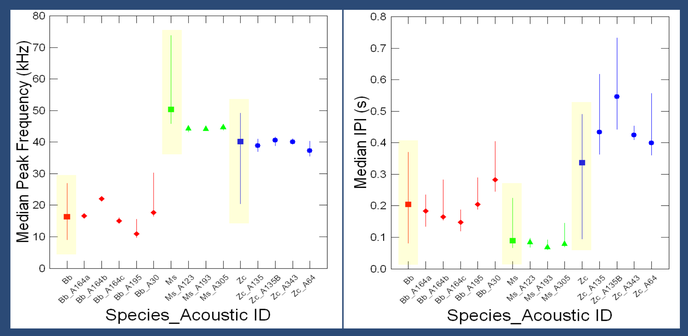


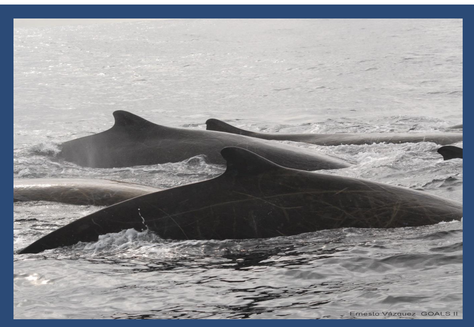
Figure 6. Boxplot showing median values and 10th- 90th percentile ranges for peak frequency and IPI click measurements by species (red = Baird's beaked whale; green = Stejneger's beaked whale; blue = Cuvier's beaked whale). Highlighted graphics represent values published in Baumann-Pickering et. al 2013.

Table 1. Summaries of the median peak frequency and IPI values (10th and 90th percentile ranges) for encounters by species from GOALSII versus published values (Baumann-Pickering et al. 2013).

Acoustic ID	*Median Peak Frequency(kHz) (GOALSII)*	*Median IPI (s)* (GOALSII)	*Median Peak Frequency (kHz) Baumann-Pickering et. al 2013*	*Median IPI (s) Baumann-Pickering et. al 2013*
Baird's beaked whale	15.9 (10.6, 22.6)	0.196 (0.1, 0.3)	16.4 (9.0, 27.0)	0.20 (0.08, 0.4)
Cuvier's beaked whale	39.4 (36.4, 41.4)	0.436 (0.4, 0.6)	40.2 (20.3, 49.2)	0.337 (0.1, 0.5)
Stejneger's beaked whale	44.5 (43.6, 45.2)	0.080 (0.07, 0.1)	50.4 (45.7, 73.8)	0.090 (0.07, 0.2)

Conclusions

- Recent advancements in acoustic methodology allowed for successful acoustic detection of beaked whales within the GOALSII survey area.
- Cuvier's beaked whales were encountered primarily in the seamount stratum.
- Baird's beaked whales were encountered more frequently in the slope stratum.
- Stejneger's beaked whales were encountered, but relatively infrequently in all strata.
- In the California current system, beaked whales have been known to associate with seamounts and north-west facing slopes (Yack et al. 2013).
  - Similar habitat associations may exist in the GOA.
- Median peak frequencies and IPI for clicks measured in this study were similar to published values.
- The results of this acoustic and visual survey provided critical knowledge necessary to assess the distribution, abundance, and habitat preferences of beaked whales.
- These findings will allow resource managers to make better conservation and management decisions.



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- Yack, T. M. (2013). *The development of automated detection techniques for passive acoustic monitoring as a tool for studying beaked whale distribution and habitat preferences in the California current ecosystem*. (Doctoral dissertation, University of California- Davis).

Acknowledgements

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