

Linking deep-water prey fields with odontocete population structure and behavior

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LONG-TERM GOALS

We seek to integrate of direct measurements of the prey environment for beaked whales to provide a critical, and previously unavailable, mechanistic link for understanding beaked whale ecology in the Tongue of the Ocean, Bahamas.

OBJECTIVES

- Measure the distribution, abundance, organization, and size of squid, fish, and other potential prey in strategically-selected areas of TOTO and nearby areas, an area with rich information on the population biology and behavior, of beaked whales
- Synoptically sample the upper and lower water column to examine the coherence between surface and deep-water prey characteristics
- Examine the relationship between historical beaked whale habitat use and prey characteristics

- Utilize existing bottom-mounted acoustic sensors within the AUTECH array and passive acoustic recorders fixed to the AUV to examine coherence between beaked whales and prey characteristics at fine spatial scales
- Quantify how prey resources may influence and potentially mitigate beaked whale responses to disturbance, providing direct input data to PCOD models for beaked whales
- Leverage previous efforts to compare predator-prey correlations at Navy test ranges in different environments in the Bahamas and southern California, identifying governing principles of cetacean foraging ecology and responses to disturbance
- Identify key prey metrics for future analyses and incorporation into PCOD models
- Work with other research teams to analytically incorporate prey in beaked whale energy budgets

APPROACH

Active acoustic sampling integrated into a deepwater AUV was combined with ship-based acoustic sampling to provide measures of potential beaked whale prey throughout the water column, ground-truthed with net tows. Beaked whale habitat use was quantified using a combination of synoptic visual observations from the ship and passive acoustics from a towed array on the ship, sensors placed on the deepwater platform, and with the AUTECH range hydrophone array. The sampling design was informed historical patterns of habitat use from other studies in the same area. The research cruise was completed July 2-14, 2015.

WORK COMPLETED

Our sampling was designed to be able to test hypotheses about food availability in various sections of the AUTECH range, the potential costs of animals leaving the range during Naval activities, and to assess differences from the Abaco area known to have a population of larger animals. Sampling utilized a blocked design to examine prey as a function of historical habitat use by beaked whales. Sampling included four, 30 km total length v-shaped transects in each of 5 zones, a high use on range habitat (1), a low use on range habitat (2), two areas of refuge immediately adjacent to the range (3, 4), and an area with remarkably different beaked whale demographics but undescribed differences in prey (5).

We were able to complete all 20 of the planned sampling Vs, resulting in 40 statistical units divided evenly amongst 5 treatment blocks. We also conducted an expanding box survey with the AUV to assess the horizontal scales of correlation at a historically important site for beaked whales surrounding the Whiskey 1 hydrophone array.

This resulted in:

- 1900 km of ship-based echosounder surveys, 80% of which was within AUTECH
- 20 deepwater trawls
- 23 AUV missions

- 680 km of echosounder data to describe potential prey between 550-1400 m, 550 km within AUTECH
- Over 300 hours of high sample rate (288 kHz) passive acoustic recordings from the AUV
- First successful detections of marine mammals recorded from AUV conducting active acoustic surveys for biological sampling
- Far-field acoustic characterization of shipboard EK-60 echosounders using calibrated recorders
- Near-field acoustic characterization of the AUV acoustic signals
- Continuous daytime ship-based visual surveys for marine mammals
- Continuous day and night ship-based passive acoustic detections of marine mammals resulting in 125 detections at AUTECH, the majority of which were Blainville's beaked whales, and 3 beaked whale groups and 2 sperm whales at Abaco



Figure 1. Sampling blocks around AUTECH and Abaco Island.

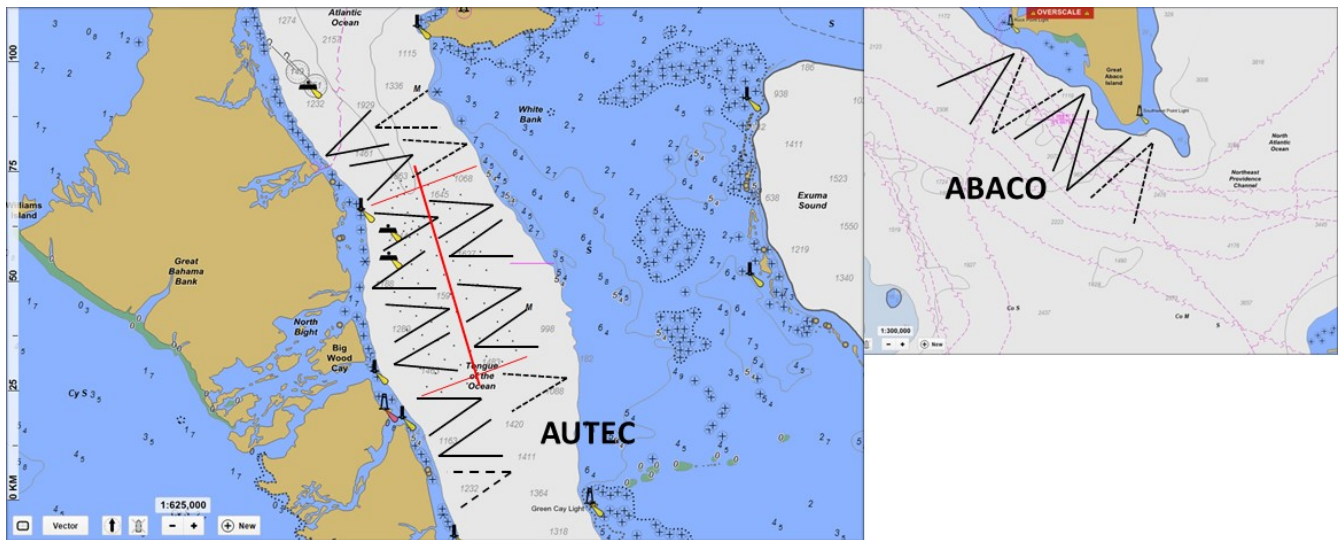


Figure 2. *Transects completed during the 2015 sampling effort are shown in black at each of the sites. Line weight/dashing was used in the cruise planning process.*

RESULTS

Data analysis of the active acoustic information at depth has begun with a focus on potential prey abundance, density, and distribution, prey clustering at scales ranging from 10 m to tens of km, and individual prey identity and size. Data obtained is of high quality and very low noise, allowing us to assess any differences in prey resources between Abaco and AUTECH, between areas within the range, and to estimate the potential losses whales suffer when they move off range as a result of naval activities. Passive acoustic and visual detections of whales that overlap with active acoustic survey efforts will be scaled to contrast the areas immediately around the animal to the surrounding sections of transect and the other transects within the same habitat zone to determine potential

IMPACT/APPLICATIONS

The work we propose will provide a mechanistic link to interpret the passive acoustic, photo identification, genetic, behavioral, and population structure data invested in previously by DoD. Our goal is to provide a comparative framework for placing beaked whales within an ecological context. The work will convert our Strategic Environmental Research and Development Program (SERDP) project from a demonstration of concept to an operational application, transitioning a variety of technologies invested in by DoD.

RELATED PROJECTS

Claridget et al., ongoing efforts to quantify the distrution of beaked whales around the Bahamas
Moretti et al., passive acoustic efforts on the AUTECH range