

## **Factors Influencing the Acoustic Behavior and Nearshore Residence of the Gray Whale (*Eschrichtius robustus*) along their Migration Route**

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### **LONG-TERM GOALS**

Our long-term goal is to quantify the acoustic behavior of gray whales in the coastal waters of the Northeast Pacific Ocean and to characterize the link between coastal residency patterns of these migratory mammals and the distribution of hyperbenthic swarms of their primary prey, mysids.

### **OBJECTIVES**

Several years of observations off the Oregon coast have revealed considerable interannual variability in the residence patterns of gray whales as well as in foraging behavior (Newell and Cowles 2006). For example, during the summer of 2005, the resident gray whale population had 50% fewer individuals than the previous three summers, and those 2005 residents displayed many fewer characteristic feeding behaviors than residents in other summers. This variability in residency and foraging was likely due to changes in the distribution and abundance of swarms of benthic mysids, the gray whale's preferred prey in this region. We have observed that the resident gray whales repeatedly forage on discrete hyperbenthic mysid swarms throughout the spring and summer months (late April – late September). As described in Newell and Cowles (2006), these discrete concentrated swarms can be found along the

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10-15 m isobath off the central Oregon coast, and interannual variability in swarm thickness and extent appears to be associated with the timing and intensity of coastal upwelling. In early summer 2005, mysid swarms were less than 1 m thick, approximately 20-30% as thick as in 2003 and 2004, likely limited by the late onset of coastal upwelling and local production (Pierce et al. 2006). These observations strongly support the hypothesis that the ecological link between ocean conditions and mysid swarm dynamics affects the spatial and temporal distribution of both migrating and resident gray whales in the eastern North Pacific. We will quantify this link between ocean conditions, mysid swarms, and gray whales through a pilot project that will assess the frequency and duration of nearshore residence and the acoustic and foraging behavior of *E. robustus* along the Oregon coast, as well as the distributional dynamics of the mysid prey.

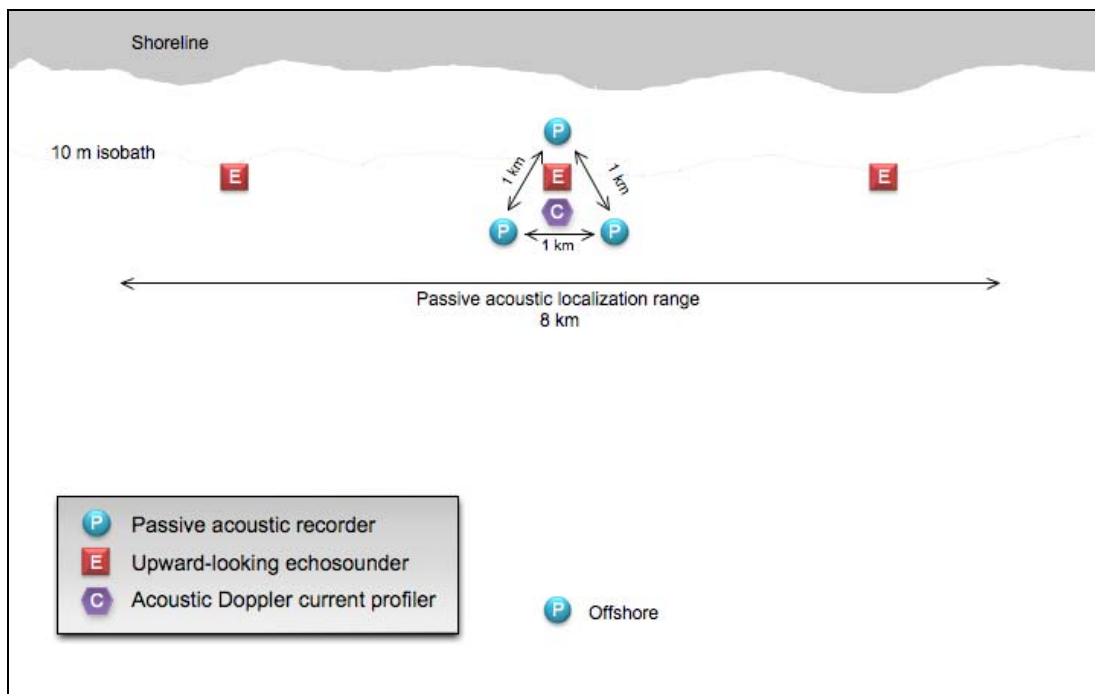
The project objectives are to:

- characterize the spatial limits for passive acoustics to identify and locate gray whales during their residency (and foraging) along the central Oregon coast;
- determine what aspects of mysid swarm dimensions and concentration can be characterized with active acoustic moorings and localized surveys with small boats;
- document the time scales of variability in mysid swarm characteristics that influence the foraging time scales of the gray whales.

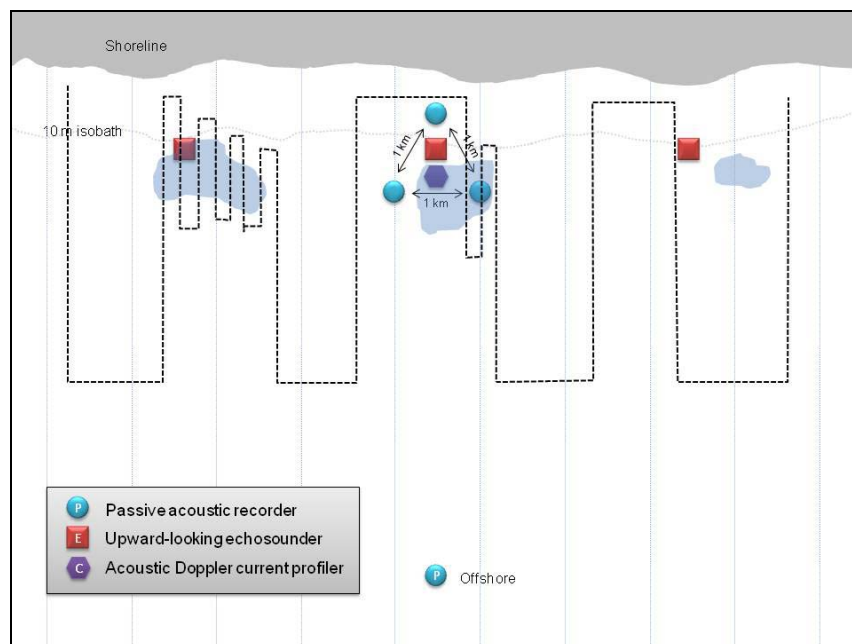
## **APPROACH**

We will use a focused, month-long observational program during the summer of 2010 that will use a variety of observational approaches, linking time series from moored passive and active devices with spatial surveys of prey availability. In addition, we will incorporate local and regional observations of ocean properties from complementary programs (PISCO, CMOP, OrCOOS) along with visual surveys of resident gray whales. Our pilot project will provide a rigorous test for the application of passive and active acoustics to localize marine mammals in relation to their prey fields, and could lead to longer-term deployments that would enhance our understanding of gray whale responses to the nearshore environment.

The month-long observational program will be based on an array of sensors installed in shallow water over the Oregon continental shelf (Figure 1). Moored passive acoustic sensors will document the patterns of distribution of the resident gray whales. We will use a small boat with active acoustics and ADCP to conduct frequent spatial surveys (Figure 2) of the dimensions and variability in the hyperbenthic mysid swarms that are the primary prey item for the resident gray whales.



**Figure 1. Schematic diagram of the proposed mooring distribution. Along the 10 m isobath we will distribute three echosounders approximately 4 km apart, with an array of three passive sensors around the central echosounder and ADCP.**



**Figure 2. Spatial survey approach to document the distribution of mysid swarms within the study area.**

## **WORK COMPLETED**

We have begun initial planning and equipment preparation for the month-long field test in the summer of 2010. During the next several months we will acquire and calibrate the sensors and establish the timeline for the small boat surveys.

## **RESULTS**

No field work has been conducted to date.

## **IMPACT/APPLICATION**

We expect that this work will illustrate the need to characterize ocean conditions and prey distribution patterns in order to fully understand the acoustic behavior of marine mammals.

## **TRANSITIONS**

None at this time.

## **RELATED PROJECTS**

ONR grant N00014-08-1-1082, “Automatic Detection of Beaked Whales from Acoustic Seaglidings”, includes the development of methods for automatically detecting odontocete clicks. Although odontocetes are not part of this gray whale project, the passive acoustic sensors record all ambient sound, and thus may provide incidental information about the occurrence and population density of the lower-frequency odontocetes present, including killer whales (*Orcinus orca*) and sperm whales (*Physeter macrocephalus*).

## **REFERENCES**

Newell, C., and T. Cowles. 2006. Unusual gray whale (*Eschrichtius robustus*) feeding in the summer of 2005 off the central Oregon Coast. *Geophys. Res. Ltrs.* 33: L22S11, doi:10.1029/2006GL027189.

Pierce, S. D., J. A. Barth, R. E. Thomas, and G. W. Fleischer. 2006. Anomalously warm July 2005 in the northern California Current: historical context and the significance of cumulative wind stress, *Geophys. Res. Ltrs.* 33: L22S04, doi:10.1029/2006GL027149.

## **PUBLICATIONS (refereed)**

None.