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# Fine-scale Focal DTAG Behavioral Study in the Gulf of Maine

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## LONG-TERM GOALS

The goal of this project is to provide technical support to Dr. Susan E. Parks from the Pennsylvania State University in order to obtain crucial baseline data on the normal diel activity budgets of endangered baleen whale species including time spent at the surface, residency time and rate of horizontal travel, and rates of sound production. These parameters are obtained by attaching a non intrusive digital archival tag (DTAG) to the whales. Recorded data can be used to assess both visual and passive acoustic detectability to aid in their detection to protect them from vessel collisions and harmful exposures to man-made sounds. DTAG data also provide information on normal behavior, necessary to interpret any potential disturbance responses to human activities.

## OBJECTIVES

The primary goal of this project is to obtain fine-scale behavior data from two endangered baleen whale species, the humpback whale (*Megaptera novaengliae*) and the right whale (*Eubalaena glacialis*), on the Stellwagen Bank National Marine Sanctuary through suction-cup attachment of sound and orientation recording DTAGs, which records subsurface movements and sound production by the whale. The specific objectives of this three year study are to use these tag data to: 1) determine the diel trends in dive profiles and horizontal movement patterns for tagged humpback and right whales on the Stellwagen Bank National Marine Sanctuary; 2) determine the sound production behavior of individual tagged humpback and right whales on the Stellwagen Bank National Marine Sanctuary; and 3) examine the relationship among anthropogenic noise, conspecific sounds, and tagged whale behavior for humpback and right whales on the Stellwagen Bank National Marine Sanctuary.

## APPROACH

The approach for this study utilizes a combination of techniques to obtain data on the behavior of individual whales and their surrounding environment. The primary method in the study involves DTAG attachment to document the activity budgets, movement patterns, and sound production of humpback and right whales on and around the Stellwagen Bank National Marine Sanctuary on three cruises from 2008-2010. These data were collected using the non invasive DTAG (Johnson and Tyack 2003) in collaboration with the Woods Hole Oceanographic Institution in three field trails in the summer of 2008 and the spring of 2009 and 2010. When possible, parameters measured by the DTAG will be related to external cues including: 1) trends in prey biomass distribution in the water column

from an active acoustic monitoring station; and 2) social sounds from conspecifics and man-made noise sources through the use of AIS ship tracking and collaboration with the NOPP led by Dr. Christopher Clark at Cornell University. These combined datasets will be used to infer diel trends in natural behavior of the whales, how the whales respond to man-made noise sources in their environment, and the effectiveness of passive acoustic monitoring in detection and tracking of individual whales.

This project brings together collaborators from a number of institutions with specialized expertise in different aspects of this project. The major participating institutions in the data collection and analysis include the Pennsylvania State University Applied Research Laboratory (Susan Parks & Jennifer Miksis-Olds), the Stellwagen Bank National Marine Sanctuary (David Wiley), and the Woods Hole Oceanographic Institution (Alessandro Bocconcelli). Additional data on prey distribution is being collected by Stony Brook University (Joseph Warren). Data integration is planned through a collaborative effort with the NOPP led by Dr. Christopher Clark at Cornell University, involving the Stellwagen Bank National Marine Sanctuary (Leila Hatch) and the Northeast Fisheries Science Center of the National Marine Fisheries Service (Sofie Van Parijs).

## WORK COMPLETED

The first cruise occurred in June and July 2008 and involved DTAG attachment to humpback whales and deployment of an active acoustic monitoring station on the Stellwagen Bank National Marine Sanctuary. The second cruise occurred in April 2009 and involved DTAG attachment to both right whales and humpback whales and deployment of an active acoustic monitoring station on and around the Stellwagen Bank National Marine Sanctuary. The third and final cruise occurred in March – April, 2010 on and around the Stellwagen Bank National Marine Sanctuary and involved tagging of right whales and humpback whales with DTAGs and deployment of an active acoustic monitoring station installed on a sub-surface mooring in Cape Cod Bay. Each of these cruises was successful, resulting in a large dataset with a total of 18 humpbacks and 16 right whales tagged and over 150 hours of fine-scale behavioral data. The tag data collected in 2010 is currently being analyzed to assess the activity budget, movement patterns, and vocalization rates of the tagged whales.

The three-frequency, active acoustic mooring station (AWCP mooring) was deployed in Cape Cod Bay for 17 days (March 28 – April 13, 2010) to detect right and humpback whale prey. Vertical plankton tows of the full water column and the top 5 m of the water column were made using a 150 micron mesh net immediately after deployment and before retrieval of the mooring station. Plankton samples were stored in a 10% buffered formalin solution for later species identification and counting. The mooring was set in approximately 30 m of water with the instruments at a depth of 25 m. The sampling protocol was designed to sample in 15 minute cycles that were repeated for the duration of the deployment. During each 15 minute cycle, all frequencies (125 kHz, 200 kHz, and 460 kHz) sampled simultaneously for 5 minutes. Upon retrieval, data from the AWCP sensors were downloaded and verified for proper instrument function.

Significant progress has been made on the analysis of data collected during the first two cruises in the summer of 2008 and the spring of 2009 and these results have been presented at several scientific conferences which are listed below:

1) Weinrich, M., Cholewiak, D., Friedlander, A., Hurst, T., Parks, S., Thompson, M., Ware, C., Wiley, D. Underwater behavior of associated humpback whales in the southern Gulf of Maine. 18th Biennial Conference on the Biology of Marine Mammals, Quebec City, Canada, October 12-18, 2009.

2) Parks, SE, Clark, CW, Johnson, M, Tyack, PL. Simultaneous acoustic tag and seafloor acoustic recorder detection of right whale calls in the Bay of Fundy and Cape Cod Bay. North Atlantic Right whale Consortium Meeting 2009, New Bedford Whaling Museum, New Bedford, MA.

3) Palmer, K., Parks, SE, Wiley, D, Weinrich, M, Tackaberry, J, Bocconcelli, A, Friedlaender, A. (2010). Vocal behavior of North Atlantic humpback whales during reunion events on Stellwagen Bank (A). Joint 159th ASA Meeting and noise-Con 2010, Baltimore, MD, 19-23 April 2010, Journal of the Acoustical Society of America. 127, 1894.

4) Parks, SE, Wiley, D., Warren, J., Weinrich, M., Bocconcelli, A. Behavioral differences in water column usage and sound production of North Atlantic right and humpback whales in April 2009 and 2010. North Atlantic Right whale Consortium Meeting 2010, New Bedford Whaling Museum, New Bedford, MA.

5) Parks, SE, Wiley, D, Weinrich, M., Bocconcelli, A. Behavioral differences affect passive acoustic detectability of foraging North Atlantic right and humpback whales. 160th ASA

   a. Meeting, Cancun, Mexico, 15-19 November 2010.

Three summary manuscripts regarding the 1) diving behavior of feeding right whales in April, 2) a comparison of diving and vocal behavior between right whales and humpback whales, and 3) comparison of stationary and mobile active acoustic methods for detection of prey species are currently in preparation for submission resulting from the data collected during this study.

**RESULTS**

A total of 9 right whales and 2 humpback whales were tagged in Cape Cod Bay in 2010 (Figure 1). Night data was only collected from a single humpback whale. Tag attachments to the right whales were longer than in 2009, but tags still were rubbed or popped off due to social interactions or swimming behavior of individual right whales, resulting in no night time data for right whales. Data from the tags have been analyzed for vocalizations and diving behavior of the whales. Table 1 summarizes the horizontal travel distance for the tagged whales from April 2010.

***Table 1. Summary of the horizontal travel distances for tagged whales from April 2010.***

| Date | Tag Event | Species | Tag attachment duration (hr) | Distance between tag attachment and retrieval (km) | Rate of travel (km/hr) |
|---|---|---|---|---|---|
| 4/2/2010 | EG10_92a | Right whale | 1.72 | 1.42 | 0.82 |
| 4/2/2010 | EG10_92b | Right whale | 1.07 | 1.63 | 1.53 |
| 4/3/2010 | EG10_93a | Right whale | 0.92 | 0.98 | 1.06 |
| 4/3/2010 | EG10_93b | Right whale | 3.07 | 0.56 | 0.18 |
| 4/4/2010 | EG10_94a | Right whale | 1.27 | 3.58 | 2.82 |
| 4/4/2010 | EG10_94b | Right whale | 0.45 | 0.47 | 1.04 |
| 4/5/2010 | EG10_95a | Right whale | 4.05 | 1.64 | 0.40 |
| 4/6/2010 | EG10_96a | Right whale | 0.52 | 1.16 | 2.22 |
| 4/6/2010 | Mn10_96a | Humpback whale | 13.13 | 3.66 | 0.28 |
| 4/12/2010 | Mn10_102a | Humpback whale | 3.7 | 3.40 | 0.92 |
| 4/13/2010 | EG10_103a | Right whale | 1.74 | 1.71 | 0.98 |

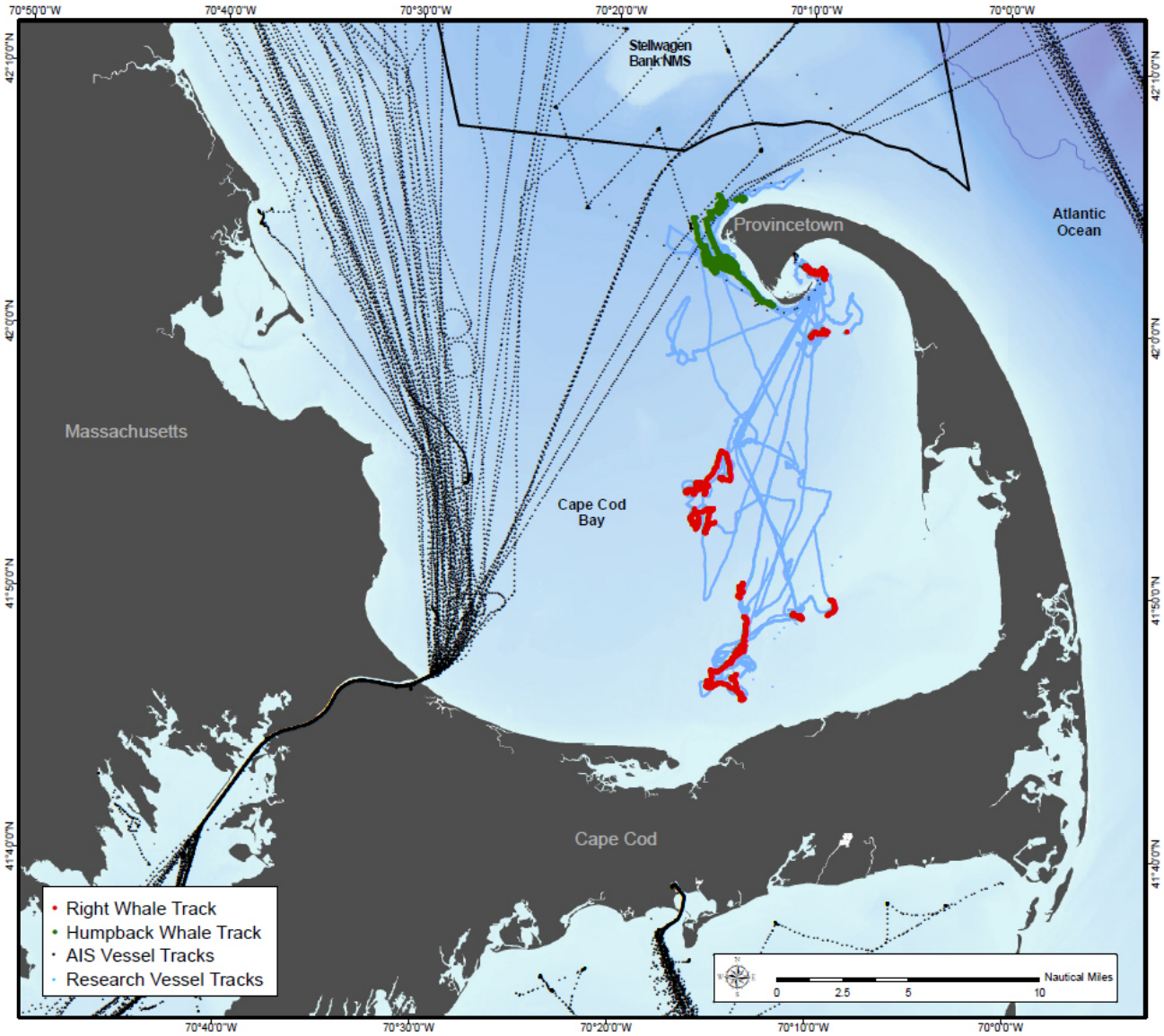


***Figure 1. A map showing tracks from humpback (in green) and right (in red) whales, research vessels, and AIS vessel tracks from Cape Cod Bay, Massachusetts in April 2010. Created by Mike Thompson/SBNMS***

Clear differences in the dive depth and behavior of humpback and right whales first described in year 2 of this study were observed again this year. Right whales spent the majority of their time at a depth of ~2 m (Figure 2). This resulted in the right whales not being visible at the water's surface, but still at a potentially hazardous depth with respect to collisions with vessels. Both humpback whales tagged utilized the entire water column during tag attachment and spent significantly less time in less than 2 m of water.

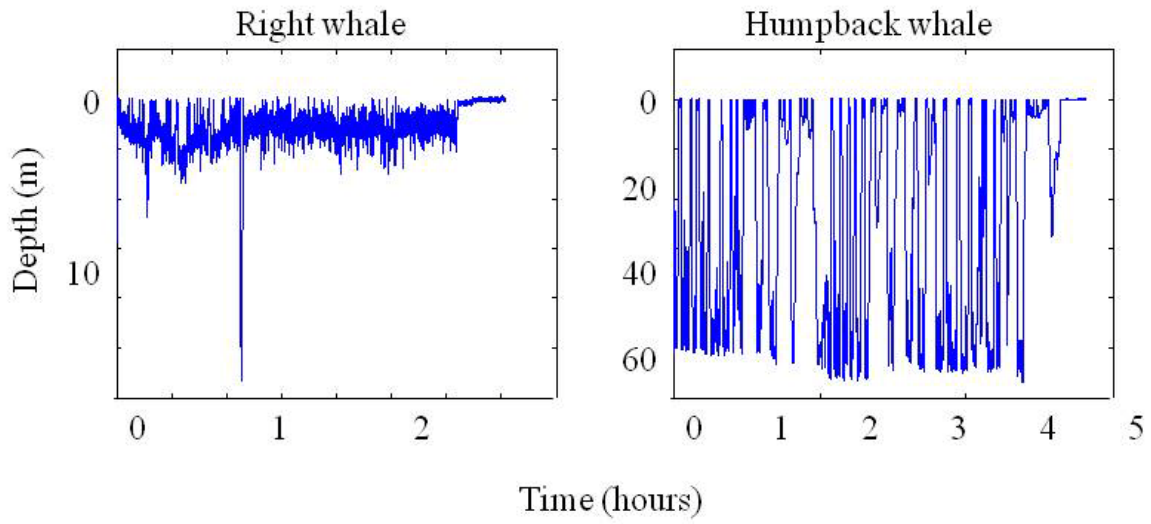


***Figure2. Example dive depth profiles from a tagged right whale and humpback whale in the same habitat area in April 2010. The right whale's depth was <2 m for all but a single dive to 14 m. The humpback whale dived repeatedly to >50 m depth during the 4 hours DTAG attachment.***

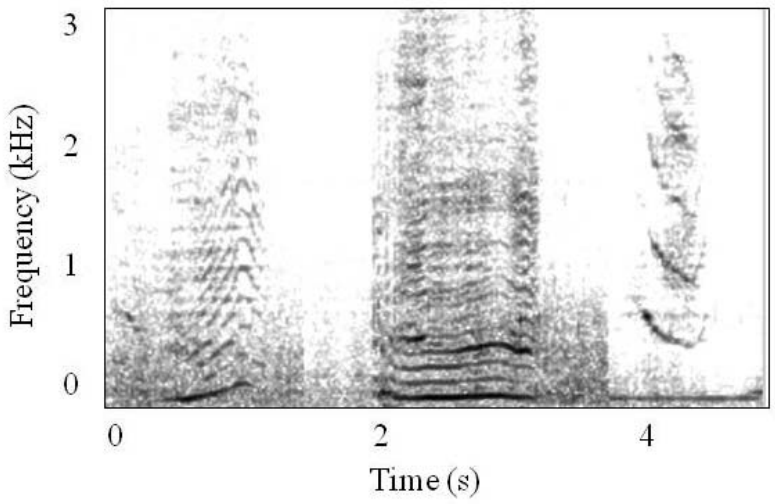


***Figure 3. Examples of 3 selected vocalization types produced by a single right whale in April 2010.***

The vocalization rates of the tagged right whales were very low during foraging. During straight line travel and socializing with other individuals, several call types were detected (Figure 3). Humpback whale vocalizations rates were lower in 2010 than in the summer of 2008 and spring of 2009.

## IMPACT/APPLICATIONS

The impacts of this work will provide baseline data on the 'normal' behavior of two species of endangered baleen whales on their foraging grounds, including diel trends in vocal behavior and movement patterns. Data on these two aspects of behavior are necessary to improve the detection rate of whales through both visual and passive acoustic surveys. Additionally, a current knowledge gap of the 'normal' behavior of particular marine mammal species makes it difficult to interpret any apparent behavioral changes resulting from response to naval activities. These data can be used to aid in the interpretation of future targeted disturbance studies and will help determine whether baleen whales spend more time at the surface at night, making them more vulnerable to vessel collision. These two species, the humpback whale (*Megaptera novaeangliae*) and the right whale (*Eubalaena glacialis*), have been selected for several reasons. Both species are endangered, vulnerable to vessel collision and entanglement with fixed gear, and have a wide global distribution. Several humpback whale stocks are showing stronger recovery than right whales, despite overlapping habitat usage on the feeding grounds in the Northern hemisphere. One aim of the study is to determine if comparisons of the behavior between the two species may shed light on the reasons for the differences in recovery of the two populations.

## RELATED PROJECTS

NOPP - "An Ocean Observing System for Large-Scale Monitoring and Mapping of Noise Throughout the Stellwagen Bank National Marine Sanctuary", led by Dr. Christopher Clark at Cornell University is collecting continuous acoustic recordings from passive acoustic recording devices distributed in an array in the Stellwagen Bank National Marine Sanctuary during the tagging cruise in this project. The data collected in this study will provide ground truth data for the NOPP system when a tagged whale travels through the array. The NOPP array potentially can provide information about the location and levels of external acoustic cues that the tagged whale may be responding to. These analyses are on-going.

This project was a close collaboration with two additional ONR funded projects, " Fine-Scale survey of right and humpback whale prey abundance and distribution" (Warren) and Fine-Scale Focal Dtag Behavioral Study of Diel Trends in Activity Budgets and Sound Production of Endangered Whales in the Gulf of Maine (Parks).

Several joint-authored publications are anticipated to result from these collaborations.

## REFERENCES

M. P. Johnson and P. L. Tyack, 2003. A digital acoustic recording tag for measuring the response of wild marine mammals to sound. IEEE J. Oceanic Eng., 28(1), 3–12.