

## **Behavioral and Physiological Response of Baleen Whales to Ships and Ship Noise**

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### **LONG-TERM GOALS**

We began this study in 2013 with goal of examining the behavioral and physiological response of blue whales to ships and ship noise off California using a combination of opportunistic and controlled research. Ship noise has been identified as the major source of anthropogenic noise in the oceans especially in areas of high vessel traffic. Ship strikes are also a growing concern especially for several species including blue and right whales that appear to be particularly susceptible. In initial research, we demonstrated the feasibility of documenting whale response to opportunistic close approaches of ships made possible by the presence of high levels of ship traffic particularly to the ports of LA/Long Beach passing through areas of known high concentrations of blue whales. This juxtaposition has resulted in high levels of ship strikes (Berman-Kowalewski et al. 2010) as well as potential impacts on vocal detections of blue whales (Melcon et al. 2012). In this study we continue research on behavioral response of blue whales to ship close approaches and specifically examine how this varies with ship speed; this is one strategy proposed to mitigate ship strikes. We will also test the response of blue whales to controlled playback of ship noise to examine the specific cues blue whales respond to and also to allow comparison between how blue whales respond to ship noise and other anthropogenic sounds like mid-frequency sonar. To gain insight into whether ship noise and frequent passages of ships might be causing a stress response, we will compare stress hormone levels in blue whales feeding for extended periods in areas of high ship traffic with those feeding away from shipping lanes.

### **OBJECTIVES**

Our objectives include:

1. Determine behavioral response (avoidance and changes in dive behavior) of blue whales and other large mystecetes to exposure to close approaches by ships.
2. Examine the stimulus that appears to trigger the response to ships and whether this is a response to ship noise or the presence of the ship.

# Report Documentation Page

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3. Examine how reaction varies with differences in ship speed and approach.
4. Determine sound exposure of a whale directly in the path of a ship.
5. Examine whether chronic exposure to ship noise causes a noticeable change in stress hormones (Keller et al. 2006, 2009).

## **APPROACH**

Our overall approach to achieve our objectives involves:

- Continuation of the work on reaction of whales to ships focused on increasing sample size of ships moving at different speeds and additional species of whales. Focus would include work with full speed ships in the Santa Barbara Channel (now that 1 December 2011 changes in the CARB regulations on clean burning fuel are resulting in ships returning to the shipping lanes through the Channel) and slower ships near the entrances to Los Angeles/Long Beach Harbors.
- Conduct controlled exposure experiments (CEE) using ship noise to blue whales using identical methodologies to the SOCAL BRS (Southall et al. 2012, 2013) to allow direct comparison of blue whale response to ship noise to that from other anthropogenic sources like mid-frequency sonar (MFA). Response to playback may or may not be similar to the response to close approaches of real ships being conducted opportunistically. This will also allow comparison to the response of right whales to ship noise from distant ships and playback (Nowacek et al. 2004) using somewhat similar methodologies.
- Obtain measurements of ship noise in the path of ships representing what whales at risk of a ship strike would experience using autonomous drifting recording hydrophones in the path of ships.
- Collect and examine stress hormone levels in biopsy samples from blue whales feeding in areas of high ship traffic such as off LA/Long Beach Harbor, especially over multiple days, compared to those from blue whales feeding farther from shipping lanes.

## **WORK COMPLETED**

Work began on the study in mid to late 2013 so only initial project activities occurred in FY2013. Work completed to date includes:

1. Collaboration with Moss Landing Marine Laboratories (Dr. Jim Harvey and graduate student Angela Szesciorka) on tag designs to provide longer term deployments of archival tags especially for work with humpback whales off northern California. This included initial tests on some modified suction cup designs.
2. Coordination with Channel Islands National Marine Sanctuary for use of their vessel in initial field efforts in 2014 off southern California.
3. Coordination with collaborators at SWFSC for testing of stress hormones in later stages of this project.
4. Conducted field efforts in 2013 as a part of other ongoing projects but which will provide some of the data to be used in the current study (McKenna et al. 2011, In Prep., Calambokidis et al. 2011, 2013). This included deployments of suction cup tags on blue

whales near shipping lanes in southern California and humpback and blue whales near shipping lanes off northern California.

5. Work has continued on the SOCAL Behavioral Response Study (under separate funding) including additional deployments and Controlled Exposure Experiments of blue whales to simulated Navy sonar and starting in 2013 real Navy ships using 53C sonar that will serve as an important basis of comparison for results from this study.

## RESULTS

This project began only in late 2013 (Awarded in Sept 2013 with a start date of 15 August 2013) so results there are no results yet from the initial work completed. Work has continued in 2013 on related projects (related to ship strike risk and the SOCAL-Behavioral Response Study) that will be valuable contributions and part of the comparison dataset related to analysis of the current study.

## RELATED PROJECTS

This project is being conducted in collaboration with several other related efforts:

1. Collaboration with Moss Landing Marine Laboratories (Dr. Jim Harvey and graduate student Angela Szesciorka) on tag designs to provide longer term deployments of archival tags especially for work with humpback whales off northern California.
2. Collaborators with Dr. Nick Kellar at SWFSC who will be receiving funding from ONR for the testing of stress hormones in later stages of this project. This component while an integral part of this study is being funded separately from our award because it is going to another federal agency.
3. Field effort in 2013 was conducted in coordination and with support of NOAA including the Channel Islands National Marine Sanctuary as a part of an ongoing project examining ship strike risk to whales off California.
4. The SOCAL Behavioral Response Study to Navy sonar (funded by the Navy's Living Marine Resources program) will serve as an important basis of comparison for results from this study.

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