Region: National

Planning Area(s): Atlantic, Pacific, and Alaska

Title: Support for JIP Controlled Exposure Experiments with Humpback Whales and Seismic Air Gun Arrays and Testing of Effectiveness of Ramp-Up (NT-10-08)

MMS Information Need(s) to be Addressed: This study will greatly expand our knowledge of the effects of sound generated by seismic survey air guns on the behavior and vocalization of migrating baleen whales, specifically the humpback whale. It will assess the effects of both seismic-survey sound intensities and the ramp-up mitigation strategy, and examine the effects of approaching versus receding air gun arrays. This information is critical for analyses and consultations under NEPA, ESA and MMPA. It would also provide scientific information on the effectiveness of the ramp-up mitigation measures. The results would be applicable to most MMS regions.

Total Cost: (in thousands) $ 2,250 plus joint funding

Period of Performance: FY 2010-2016 with extension of the POP

Conducting Organizations:
Defence Science and Technology Organisation, Australian government
School of Geosciences, University of Sydney, Sydney, Australia
Australian Antarctic Division, Australian Marine Mammal Centre, Tasmania, Australia
Centre Marine Science and Tech., Curtin University of Technology, Perth Australia
Cetacean Ecology and Acoustics Laboratory, School of Veterinary Science, University of Queensland, St. Lucia, Australia

BOEM Contact: James Price

Description:
Background: For several years, the Joint Industry Program on Exploration and Production Sound and Marine Life (JIP) has been coordinating cooperatively funded research on the effects of industry-generated sound on marine life with a focus on marine mammals. Through the JIP, the offshore oil and gas industry and governmental agencies jointly fund research intended to provide information needed to assess and minimize adverse environmental impact. One important information need is the effect of sound generated by seismic surveys on the behavior and vocalization of baleen whales. To address this issue, a controlled exposure experiment (CEE) testing for behavioral effects to humpback whale migration is under development by researchers at the (Australian) Defence Science and Technology Organisation, the (Australian) Antarctic Division, the Centre for Marine Science and Technology (Australia), and the Cetacean Ecology and Acoustics Laboratory (Australia). The JIP is coordinating the funding for this project,

looking for support from the MMS, NOAA, ONR, NSF (which may be providing the NSF seismic-capable research ship the R/V Marcus G. Langseth) and the Australian federal government.

The proposed research has been informed by extensive earlier work on humpback whales in Australian waters. In nearshore waters off eastern Australia, the Humpback Whale Acoustic Research Collaboration, was conducted 2002, 2003, 2004 and 2008 (Noad et al., 2004; Thode et al., 2004, 2006; Dunlop et al., 2007, 2008; Noad and Cato, 2007; Smith et al, 2008). Previous studies have found behavioral reactions of baleen whales to air gun sounds (Richardson et al., 1995; McCauley et al., 2003) but there is little information on whether these have any impact beyond the immediate reaction, such as on life functions (i.e. behavioral changes that can negatively impact on an individual's survival or fecundity). Over the past years, substantial information about humpback whale migration, biology, population dynamics, and behavior and acoustics has been obtained. This information is crucial to modeling and infering the effects of offshore industrial activities on the life functions of the exposed animals.

This previous work has shown that humpback whales show a wide range of behaviors and there is complex interaction between individuals over scales of kilometers. In the proposed study, there will be multiple scales of observation and measurement of a wide range of variables likely to affect whale response. This will allow the effects of air gun arrays to be teased out and related to those of other stimuli and to normal whale interactions. The study will be structured to allow generalization of the results to different seismic air gun array configurations by use of a scaled array.

Additionally, a pilot study testing the equipment and methods proposed for this study will be conducted in 2009, in advance of the full experiment beginning in 2010.

Although the oceanographic conditions of the experimental sites in Australia (two are proposed) have no exact analog in U. S. territorial waters, and although the humpback whale populations are not exactly identical to humpback whale populations living in or migrating through U. S. territorial waters, there is likely enough similarity in the environmental conditions and the physiology of the whales to regard the results of such a study performed in Australia as applicable to U.S. waters. Also, the sound sources and subsequent sound exposures utilized in this CEE will be representative of industry seismic practices in both the U.S. and Australia.

The proposed study will avail itself of a unique convergence of research infrastructure and controlled, government-permissible sound exposure to the whales (as well as opportunistic sound exposure from a planned industry seismic survey). These favorable conditions would be difficult to reproduce in U. S. territorial waters at the present time. Therefore, this project offers MMS a chance to acquire valuable environmental impact data that currently is not so readily and comprehensively available by other means, yet it is important in supporting MMS environmental assessments and decision-making.

Furthermore, given that there is little existing scientific information on air gun effects on baleen whales and even less information on the effectiveness of ramp-up, the results of this study will add significantly to the current scientific knowledge base.

Objective: This project aims to determine the dose response of migrating humpback whales exposed to sound generated by seismic air gun arrays and also test the effectiveness of the ramp-up or soft-start procedure as a mitigation measure in offshore seismic surveys.

Methods: The proposed project will be a controlled exposure experiment combining the use of a commercial seismic array and controlling the individual stages of the ramp-up procedure used in surveys (single air gun, two air guns, etc.) to determine behavioral response of humpback whales and dose response to a range of exposures. The reactions will be placed in the context of normal behavior and reactions to other stimuli that may be encountered by the whales. The effects on life functions will then be inferred through modeling, using the substantial body of data on normal behavior, vocalizations, and their functions that already exist for the populations studied.

Received sound levels (the sound exposure from the source level minus the transmission loss) of the air guns at the whales will be determined from measurements at many positions in the study areas, using measured and modeled propagation loss. Digital recording tags will also be attached to whales for this purpose and for recording the dive profile. Measurements will also include ambient noise and received levels of other stimuli such as vocalizing whales and vessels. Whales will be tracked both visually and acoustically from vocalizing whales in the study areas. They will use knowledge of migration behavior to ensure that no individual is exposed more than once.

There will be two experimental regimes and two study sites: one offshore (off Western Australia) and one inshore (off eastern Australia). One experimental regime, used only at the offshore site, will be the exposure of whales to a commercially-sized seismic survey. The second regime will involve controlled exposure of whales to ramp-up and its components, and will be used at both sites. The experimental regime at the inshore site will be repeated in abbreviated form at the offshore site to link reactions at the two sites. Control observations will be made at both sites with the vessel towing the air gun array but without firing and also in the absence of the vessel. Varying the seismic exposure and working on two different whale populations helps avoid pseudo-replication (McGregor, 2000) and allows generalization of the results.

Results of previous studies have been used in power analysis to determine the sample size needed for the experiments. Statistical analysis will include Generalized Linear Mixed Models using multiple measures of behavioral response.

Reactions to air guns will be compared with this range of behaviors and other datasets, and reactions to other stimuli such as vocalizing and surface active whales, high levels of ambient noise, passing vessels and playback of tones and humpback whale vocalizations.

Current Status: **Completed**

Final Report Due: **December 31, 2017 (revised date)**

Publications:

Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity, Rebecca A. Dunlop, Michael J. Noad, Robert D. McCauley, Lindsay Scott-Hayward, Eric Kniest, Robert Slade, David Paton, Douglas H. Cato, Journal of Experimental Biology 2017 220: 2878 – 2886; doi: 10.1242/jeb.160192

Affiliated WWW Sites:
http://www.brahss.org.au/

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