

Cooperative Research on Sperm Whales and their Response to Seismic Exploration in the Gulf of Mexico

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Introduction

In the Gulf of Mexico, sperm whales forage for deep-living prey in continental margin areas that are receiving increasing human effort in exploration for and production of oil and gas. Because these endangered species use echolocation "clicks" to search for their prey at depths of 500-2000 m, federal regulatory agencies have expressed concern that sperm whales may be impacted by anthropogenic noise produced by geophysical seismic surveys. To address this concern, TAMU scientists based in College Station and Galveston worked in partnership during summers 2002-2005 with colleagues from seven other universities for a cooperative study of sperm whales, their habitat in the Gulf of Mexico, and their response to man-made noise.

Our cooperative Sperm Whale Seismic Study (SWSS) was sponsored by the Minerals Management Service in cooperation with the Industry Research Funders Coalition (IRFC), National Science Foundation (NSF), and Office of Naval Research (ONR), with additional support provided by the National Fish and Wildlife Foundation (NFWF). This study was conducted in cooperation with scientists from Oregon State University (OSU), Woods Hole Oceanographic Institution (WHOI), Scripps Institution of Oceanography (SIO), University of Colorado (CU), University of South Florida (USF), University of Durham (UD), University of St. Andrews (USStA), and a UK small business venture called Ecologic Ltd. A Science Review Board was established to provide

review and comment on the Summary Report for 2002-2004 and the project's final Synthesis Report. This board consisted of five members: one from the federal government (NOAA), one from industry, one retired from the Marine Mammal Commission, and two from the academic community. All activities involving sperm whales were performed under the terms of valid permits from NOAA Fisheries.

In 1991, MMS began a series of environmental studies to investigate cetaceans in the Gulf of Mexico. In the 1990s, the MMS-sponsored *GulfCet* Study used ships and aircraft to survey the western and eastern parts of the northern Gulf to determine seasonal variability in the occurrence and distribution of marine mammals (Davis et al. 1996, 2000). In 1999, MMS hosted a Gulf of Mexico Protected Species Workshop (McKay *et al.* 2001) to review past research, evaluate new issues, and recommend research priorities. MMS, ONR, and the National Marine Fisheries Service (NMFS) then sponsored the Sperm Whale Acoustic Monitoring Program (SWAMP) in fiscal years 2000 and 2001. SWAMP was a pilot study that developed methods and began documenting a baseline on "usual" behavior of sperm whales in the Gulf of Mexico. This study, as well as earlier survey results, indicated that sperm whales tend to be most likely observed near the 1000-m isobath.

As oil and gas activities in the deepwater Gulf of Mexico increase and move into deep water, the potential increases for them to occur in regions frequented by the endangered sperm whale. At the 1999 MMS Workshop, a panel of experts identified the potential effects of noise from seismic operations on sperm whales as a key research priority. During the January 2002 MMS Information Transfer Meeting, the International Association of Geophysical Contractors (IAGC;

now part of the IRFC) hosted a meeting to discuss future acoustic research relevant to seismic operations, and in particular, as related to understanding the effects of seismic exploration on sperm whales in the Gulf of Mexico. IAGC offered its support for sperm whale research through contribution of a seismic source vessel for controlled exposure experiments. In response, SWSS was proposed and approved by MMS in April 2002 under a Cooperative Agreement between MMS and the scientists.

Description of Cooperative Research

The study consisted of four summers of field research, 2002-2005, followed by analysis and synthesis. The study area was primarily the northern Gulf of Mexico, with focus during the first three summers on the region immediately off the Mississippi River Delta. In the fourth summer, some work was done in the northwest Gulf to provide information for comparison with the main study area (Figure 1).

The objectives of SWSS were three-fold:

- (1) establish the "normal" behavior of sperm whales in the northern Gulf of Mexico,
- (2) characterize habitat use, and
- (3) determine possible changes in behavior of sperm whales when subjected to man-made noise, particularly from seismic airgun arrays.

In addition to program management (TAMU), SWSS consists of six components: S-tag (OSU), D-tag (WHOI, UStA), mesoscale population biology (TAMU, Ecologic, UStA), genetic analyses

(UD), habitat characterization (TAMU, CU, OSU, and USF), and passive acoustics research (SIO). MMS provided fiscal support, project oversight, and cruise participants under the Cooperative Agreement. ONR provided funding for development of both the S-tags and D-tags used in this study. IRFC provided the seismic source vessel and its crew for the controlled exposure experiments in summers 2002 and 2003, as well as funding to support the Mesoscale Population Study in summer 2004, and purchase and support of the 3-D passive acoustic tracking array in summers 2004 and 2005. NSF provided the R/V *Maurice Ewing* as the science vessel for the controlled exposure experiment in summer 2003, as well as support for other, non-SWSS acoustics studies. NFWF provided funds to support the charter and operation of the motor sailor used in the MPS cruise in summer 2004.

The S-tag component was designed to monitor seasonal changes in distribution of sperm whales in the Gulf of Mexico and to identify behaviors, summer and other seasonal habitats, and, in coordination with the habitat characterization task, associations with oceanographic features. The D-tag component was designed to quantify diving behavior and vocalizations in Gulf sperm whales on short time scales (hours) and to conduct controlled exposure experiments to measure reactions of these whales to controlled airgun sounds. The Mesoscale Population Study used photo-identification, photogrammetry, and passive acoustics to study sperm whale group behavior and coda analyses; in summers 2004 and 2005 this work was conducted aboard a quiet sailboat so that specific whale groups could be studied over several days. The genetic analyses component allowed study of groups of sperm whales in terms of relatedness through DNA analyses of skin/tissue samples, including comparisons with populations sampled outside the Gulf of Mexico. The habitat characterization component merged biological oceanography, physical

oceanography, and remote sensing data to provide an interdisciplinary description of the oceanographic habitat in which sperm whales are encountered. Passive acoustic experiments were conducted to estimate 3-D whale locations underwater from their sounds.

During SWSS 2002-2005, there were four S-tag cruises, two D-tag cruises with controlled exposure experiments using airguns on seismic vessels provided through IRFC, one cruise for a sperm whale survey and habitat characterization study conducted concurrently with the D-tag cruise for that year, and two mesoscale population study cruises aboard a 46' Hunter sailboat. In Table 1 are given the cruise type, ship name, and cruises dates for all four years.

Reporting

Annual Reports summarizing data collection activities on the cruises have been completed (Jochens and Biggs, 2003, 2004, and 2006). A Summary Report was completed in 2006; it presents the results of the individual program components based on field work from 2002-2004 (Jochens et al. 2006). All four reports are available online from MMS at http://www.gomr.mms.gov/homepg/regulate/envIRON/techsumm/rec_pubs.html. They document that we've learned a great deal about sperm whale population ecology, and our research synthesis that is now in progress will be the basis for recommendations for how the oil and gas industry can mitigate anthropogenic impacts to allow a healthy population of sperm whales to remain for future generations. This Synthesis Report for SWSS was in preparation at the time of this SPE Meeting; it should become available in late summer or early fall 2007.

Acknowledgement

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Table 1

2002-2005 Cruises Conducted for and Related to the Sperm Whale Seismic Study

Ship	Cruise	Dates
2002		
R/V <i>Gyre</i>	S-tag	06/20/2002 - 07/08/2002
R/V <i>Gyre</i>	D-tag	08/19/2002 - 09/15/2002
M/V <i>Rylan-T/Speculator</i>	CEE ¹ with <i>Gyre</i>	08/29/2002 - 09/12/2002
2003		
R/V <i>Gyre</i>	Whale & Habitat Survey	05/31/2003 - 06/21/2003
R/V <i>Maurice Ewing</i>	D-tag	06/03/2003 - 06/24/2003
M/V <i>Kondor Explorer</i>	CEE ¹ with <i>Ewing</i>	06/07/2003 - 06/22/2003
R/V <i>Gyre</i>	S-tag	06/26/2003 - 07/14/2003
2004		
R/V <i>Gyre</i>	S-tag	05/24/2004 - 06/19/2004
<i>Summer Breeze</i>	MPS ²	06/20/2004 - 08/15/2004
2005		
R/V <i>Gyre</i>	S-tag	06/02/2005 - 06/20/2005
<i>Summer Breeze</i>	MPS ²	06/13/2005 - 08/03/2005

¹CEE is the controlled exposure experiment using airguns of the seismic source vessel.

²MPS denotes the Mesoscale Population Study cruise from the 46' Hunter sailboat.

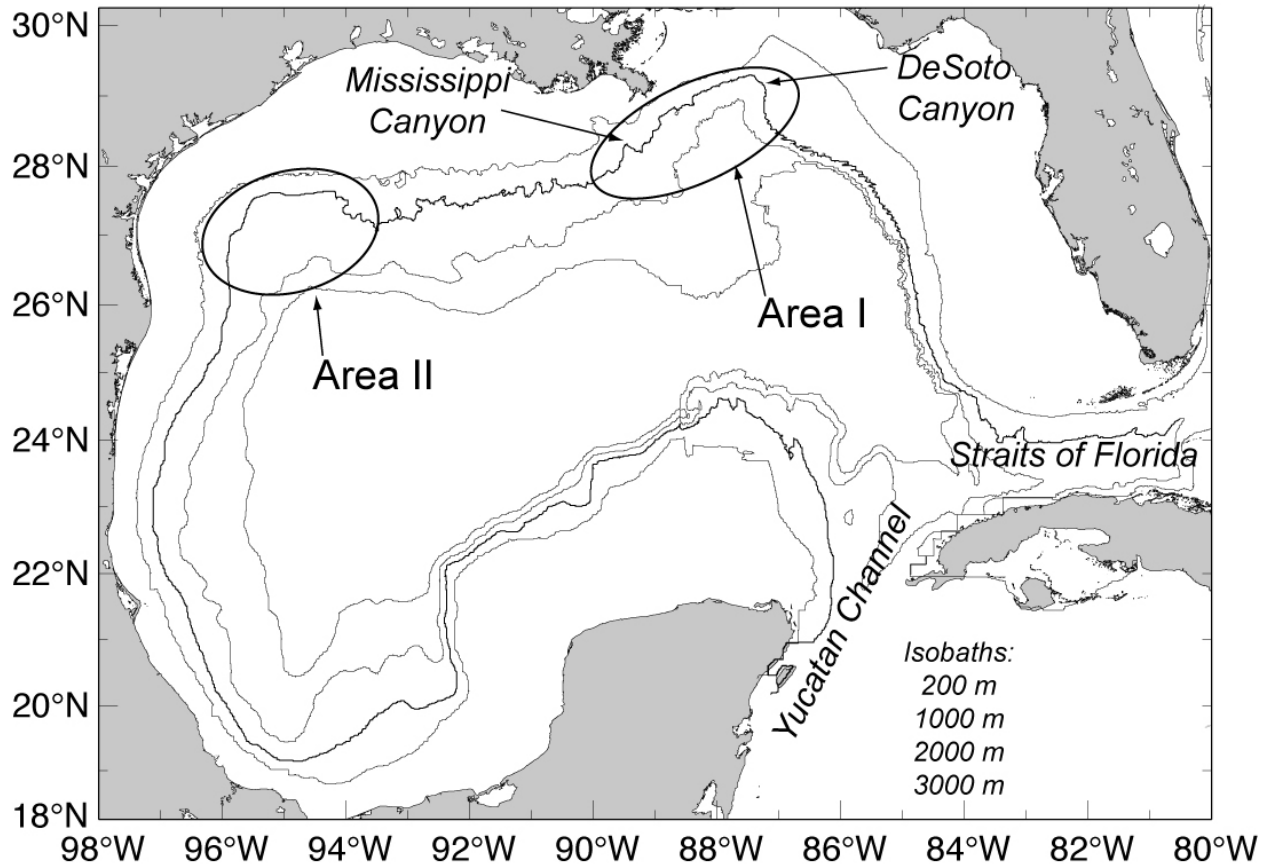


Figure 1. SWSS study area in the Gulf of Mexico. Area I was the focus for SWSS cruises in summers 2002-2004 and for the MPS cruise in summer 2005. Area II was the focus area for the 2005 SWSS S-tag cruise. Several cruises also conducted brief surveys along the 1000-m isobath between the two areas. Shown are the 200-m, 1000-m (thick line), 2000-m, and 3000-m isobaths.