

**Satellite Tracking of Sperm Whales in the Gulf of Mexico in 2011, a Follow-up to the Deepwater Horizon Oil Spill**

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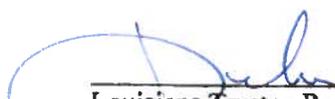
Approval of this work plan is for the purposes of obtaining data for the Natural Resource Damage Assessment. Each party reserves its right to produce its own independent interpretation and analysis of any data collected pursuant to this work plan.

This plan was implemented consistent with existing trustee regulations and policies. The fieldwork detailed in this plan was completed between July 7, 2011 and August 6, 2011. All applicable state and federal permits were obtained prior to conducting work. A permit for the tags, biopsies, photography, and close re-approach for visual assessments of sperm whales was issued by the National Marine Fisheries Service (NMFS) to Dr. Bruce Mate under the authority of the Marine Mammal Protection Act and Endangered Species Act. The activities carried out during this cruise were conducted under Marine Mammal Protection Act Research Permit 369-1440-01. Similar tagging work was conducted in 2010 pursuant to the *Collection of Data to Determine Impacts of the Deepwater Horizon Mississippi Canyon 252 Incident on Endangered and Protected Marine Mammals in the Northern Gulf of Mexico* plan (aka Gordon Gunter Plan).

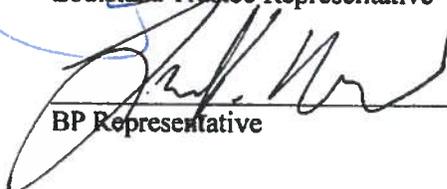
The trustees have developed a preliminary conceptual model of the DWH release, potential pathways and routes of exposure, and potential receptors. This preliminary model has informed the trustees' decision to pursue the studies outlined in the work plan. By signing this work plan and agreeing to fund the work outlined, BP is not endorsing the model articulated in the work plan.

  
Department of Commerce Trustee Representative

10/12/2011  
Date

  
Louisiana Trustee Representative

10/25/2011  
Date

  
BP Representative

Oct. 13, 2011  
Date

# **Satellite Tracking of Sperm Whales in the Gulf of Mexico in 2011, a Follow-up to the Deepwater Horizon Oil Spill**

## **Introduction**

Regular occurrence of sperm whales in the Gulf of Mexico (GOM) is known from whaling records of the late 1700s (Townsend 1935), and more recent dedicated aerial and shipboard surveys have confirmed the year-round occurrence of sperm whales in the northern Gulf (Mullin and Hoggard 2000; Mullin and Fulling 2004; Mullin et al. 2004). However, relatively little was known about their seasonal distribution patterns and movements. From 2002 – 2005 the broad scale, multi-disciplinary Sperm Whale Seismic Study (SWSS) was funded by Minerals Management Service (MMS) with support and cooperation from the Industry Research Funders Coalition (International Association of Geophysical Contractors (IAGC) and oil and gas companies), National Fish and Wildlife Foundation, National Science Foundation, and Office of Naval Research in an effort to address the effects of offshore seismic surveys on sperm whales in the Gulf of Mexico. This study added immensely to the knowledge of GOM sperm whales.

The Oregon State University Marine Mammal Institute was a major participant in the SWSS project, deploying 53 satellite-monitored radio tags on sperm whales during annual cruises. With an average tag duration of 192 days (maximum of 620 days), investigators were able to create home range estimates for sperm whales and describe seasonal distributions in a variety of environmental conditions over multiple years. Biopsy samples collected during tagging allowed investigators to differentiate between sexes, describe different ranges between the sexes, and identify the genetic relationship among individuals (Ortega et al. accepted). Female sperm whales primarily moved east to west, staying along the upper continental slope within 250 km of the tagging location, and rarely moving into water >2000 m. Males ranged over larger areas within the GOM and into deeper waters, including southwest into the Gulf of Campeche. One male moved into the North Atlantic for 2+ months, traveled north to South Carolina and returned to the GOM via Cuba after a hurricane passed nearby. It ranged widely in the northern Gulf during the second summer after it was tagged, suggesting that the entire upper Gulf was its summer feeding range. During 2002-2004, whales were tagged in the upper Gulf from the Mississippi Canyon to DeSoto Canyon. Tracking data from these efforts determined that the home range of females from those areas extended to the western Gulf. Tagging in the western Gulf in 2005 showed that the home ranges of whales in the west overlap those of whales from the central and eastern Gulf, but that their respective core areas are separate.

The multiple years of satellite tag data from the SWSS project may provide a baseline for sperm whale movements and distribution in the northern GOM. The oil released by the sinking of the Deepwater Horizon oil rig moved through areas of the sperm whale home range identified by the SWSS project with the potential to change sperm whale behavior and distribution in direct response to the spill or as a result of food web changes to their prey base, which is composed almost exclusively of squid. Early assessment of sperm whale movements during and immediately after the spill shows that some of the whales stayed in the general region and seemed to skirt the edges of the heaviest surface-visible oiled areas.

With the exception of a handful of GPS/TDR tags in the Gulf of California, previous sperm whale tagging studies used location-only tags on sperm whales. The Argos tagging efforts with Telonics ST-15 tags to be conducted under this plan will provide whale observations, seasonal movement, and behavior data that can be compared to pre-spill data collected during the SWSS studies as well as the work conducted during the spill event in 2010. In addition, however, the Wildlife Computers 2011 tags will provide detailed dive data to help evaluate and interpret the effectiveness of passive acoustic devices (HARPs and MARUs) deployed in the GoM as part of the overall offshore marine mammal study. GPS location data of GPS/TDR-tagged whales can be used to understand the ranges at which the acoustic recorders can “hear” whale sounds (clicks and creaks). The precision of the GPS/TDR tags may also allow for the gathering of habitat utilization data in three dimensions, including whether the maximum dive depths vary diurnally, along with movements of deep scattering layers which will likely be shallower at night. The GPS/TDR tags may pick up feeding attempts or “lunges” which can potentially provide insight into feeding effort and prey availability through the day and night. Data collected from this study are similar to that collected in the past and will provide insight into distribution and abundance and potentially develop valuable information that will allow for better management of these protected resources.

The study under this plan will also employ passive and active acoustics. The towed-array passive acoustics will assist significantly in locating whales at night and staying with them to increase tagging efficiency in the morning, and can provide some information on distribution and abundance of whales. The active acoustics using three Simrad EK60 echosounders (38, 70 and 120kHz) will generate data that can be compared at the lowest frequency to those gathered during the February 2010 whale prey study conducted by NOAA and the data collected during the Gordon Gunter cruises completed in 2010. The Simrad EK60 has also been used by other NRDA technical working groups to document backscatter and biomass in the open-ocean environment. Changes to sperm whale foraging success could potentially be detected during 2011 if the squid populations were affected by the spill. Comparing the typical squid back scatter "signature" with the dive depths of the TDR-equipped whales will allow observations regarding sperm whale feeding and depth of dive changes by day and night.

Copies of all data used in the comparison (2010 NOAA study and 2010 Gordon Gunter study) will be provided to BP and the Trustees upon request and within a reasonable timeframe.

### **Study Objectives**

1. Obtain a better understanding of 2011 sperm whale movements, including home range, core areas, and habitat utilization; diurnal behavior, and foraging behavior, and abundance and distribution, through collection of satellite tag and dive tag data
2. Determine any differences between such movements in comparison with previous datasets.
3. If practicable, obtain a better understanding of the movement of Brydes whales, by tagging up to 5 of them opportunistically.
4. Collect echosounder data using the Simrad EK60 to assess biomass in an effort to understand squid abundance and distribution, and obtain a better understanding of squid species in the vicinity of sperm whales through opportunistic sampling

5. Obtain visual information on the health condition of tagged whales
6. Determine sex and genetics of biopsied, tagged sperm whales

## **Study Design**

Under this Plan, up to 30 satellite-monitored radio-tags of two types (Argos location-only and Argos-linked) will be placed on sperm whales in the northern Gulf of Mexico in the vicinity of the Deepwater Horizon oil spill. Biopsy samples will also be collected per permit requirements either simultaneous with tagging or as a follow-up activity. Samples will be stored appropriately for later genetic, stock and possible stable isotope analysis. Passive acoustics will be used to aid in locating whales. Scientific echosounder data will be collected to assess the vertical and horizontal distribution of plankton and micronekton, and jigging for squid may identify some of the species in the vicinity of sperm whales. If practicable, up to 5 Wildlife Computers Spot-5 tags will be deployed on Brydes whales and tracked to determine movement details for up to 6 months. In addition, a panel of cetacean veterinarians will evaluate video and photographic images to reach conclusions regarding the health status of animals tagged under this study.

An analysis plan for sperm whale tagging data and acoustics will be developed cooperatively by the Trustees, BP and OSU. OSU will provide a proposed draft of the plan by October 14, 2011.

The tagging cruise will leave from Houma, LA on the *M/V Sarah Bordelon* in early-July and work for up to 30 days deploying two types of tags -- location only tags (using Telonics ST-15 transmitters) and Wildlife Computers Mk-10 GPS/Time-Depth-Recorder (TDR) tags. The vessel has been procured by Oregon State University. Information from previously tagged whales in this area and information from other NRDA-related ships, aerial surveys, and the chartered vessel's visual and acoustic observers will be relied upon to find sperm whales between Mississippi Canyon and DeSoto Canyon. Once the whales are found, a 6.5 m rigid-hull inflatable boat (RHIB) will be used to approach and tag them. Tagging operations will only occur during daylight hours. The search area historically has had a high number of sperm whale sightings, and tagged whales have spent extended periods in the region during previous years.

While tags could all be placed in one geographic area (number of whales permitting), the preference will be to spread the tags across a wider region, by tagging up to 3-4 whales in each social aggregation found. This protocol will provide a means of tracking aggregations of females and will provide additional data on the degree of coordination in the dive patterns with the GPS/TDR -tagged whales. If we do not find aggregations, then we will tag individuals. If groups are common, we will concentrate on those initially and "fill-in" our total sample size by tagging single whales. The main emphasis on groups will be with the Mk-10s to inform consistency in dive depth behavior within and between groups. Depending upon time and number of whales present, the primary work area will be in the 800–1500m depth contour region from western Louisiana to Florida.

The passive acoustic monitoring (PAM) equipment will be used primarily at night to find whales as the ship runs zig-zag transect lines through likely sperm whale habitat based on historical

results from the SWSS study (*Figure 1*; Mate, in prep.) and the results of the 2010 Gordon Gunter whale study. Animals detected at night will be followed so they can potentially be tagged the following day.

Animals will be identified through visual sighting (day time), or by passive acoustic detection (by towed arrays at night), or by deploying portable hydrophones from the RHIB during the day running a parallel or perpendicular grid to the mother vessel at a range of 3-8 miles from the ship. Once identified, (unless the RHIB is already in the water), the Sarah Bordelon will launch a tagging vessel (RHIB) by an articulated A-frame on the back deck. The tagging vessel crew of five will consist of a driver, two taggers, a biopsy person, and a photo ID person. The driver, taggers, and biopsy person will each wear high-speed video helmet cams to document the tagging process (position on the whale and depth of penetration). Tags will be deployed using an air-powered applicator at close range ( $\leq 3$  m). Biopsy samples will be collected by crossbow either simultaneous with tagging or as a follow-up activity. Photographs and potentially video will be taken of each tagged whale. Dr. Mate and a panel of marine mammal veterinarians will be designated cooperatively by the trustees and BP to evaluate the condition of the whales based on the photo and video data.

Location only tags (using Telonics ST-15 transmitters) will be applied on up to 18 individuals, and Wildlife Computers Mk-10 GPS/Time-Depth-Recorder (TDR) tags will be deployed on up to 12 individuals. Where practicable, the GPS/TDR tags will be applied simultaneously with the location-only tags on up to 12 individuals. Thus, the goal is to tag at least 18 whales, 12 with GPS tags providing more accurate location data, which will be used to assess the accuracy of Argos locations from both tag types. The GPS/TDR tags provide 1s and 2m resolution on dive habits for up to 45 days, as well as 3-axis accelerometer data which will provide the body orientation and direction of whale travel during dives. When multiple animals are being tracked, the tracking data will collectively aid in understanding the size of the area being used by animals in their social aggregation.

If it is not possible to double-tag whales simultaneously, GPS/TDR tags will be deployed on untagged whales to the limit of our permit (total of 25 tagged whales/year). Whales must be oriented to the boat in a specific manner in order to be tagged with GPS/TDR tags. Decisions regarding whether to deploy a GPS/TDR tag or a location-only tag or whether to double-tag a given whale must be made on a case by case basis. If whales cannot be double-tagged, GPS/TDR tags will be given priority when practicable, until 3 to 4 GPS/TDR tags are in place in each area. Whales will then be tagged with either GPS/TDR or location-only tags until the appropriate ratio of tags is met. The dive data from the GPS/TDR tags will provide data concerning the foraging habits of sperm whales over multi-day periods and will help assess the degree of coordination or independent activity by social cohorts. These data should provide documentation of variability among individual whales, diurnal foraging activity, as well as regional or site-specific differences. The GPS/TDR tags will also provide summary information about the duration, maximum depth and dive shape of foraging dives, and their GPS location via Argos while still attached to the whales.

The GPS/TDR tags will be programmed to eject off the whale on a specific date at least 15 days after the last tags have been deployed, and will float to the surface. There they will transmit their

location to allow re-location and recovery by a separate small boat operation in order to obtain the highly detailed data stored onboard the tags. Tags ejected in range while the Bordelon is still out on its tagging mission will be picked up by the Bordelon. When recovering ejected tags, the crew will look for, and photograph, whales with tags still-attached; whales with stainless steel attachment sleeves that held the GPS/TDR tags still attached, and, within the same social grouping as tagged whales, whales with evidence of tags from previous seasons to evaluate potential tag effects, the condition of remaining tags, and the size/composition of whales in the social grouping. Echosounder data from 38- 70- and 120 kHz EK-60s will be collected during the search for sperm whales several times each day, throughout the night, and in close proximity to previously GPS/TDR-tagged whales to identify potential backscatter from squids in the GoM and in sperm whale inhabited areas. These data will also be used to compare the most recent dives of sperm whales reported from the recently recovered GPS/TDR tags.

Animals to be tagged will be determined by selection criteria that exclude calves, small juveniles, and any signs of animals being compromised (such as emaciated or “skinny” whales, or excessive visible parasites). Tags will be deployed near the mid-dorsal line and within several meters forward of the dorsal hump with a preferred vertical antenna orientation. The GPS/TDR tags will be scheduled to transmit 24 hours/day. The location-only tags will initially transmit during only four one-hour periods daily on alternate days or for the first 45 days and subsequently on alternate days to extend the duration of the tags’ operational life. Satellite tag locations are typically available within two hours of the satellite pass and could be used in near real-time to further direct the Sarah Bordelon’s search if whales are not easily found during visual and acoustic surveys.

Statistical analyses of the Argos location data will involve evaluating whale movements, speeds, home ranges and core areas, and comparing these data with similar tagging data from previous years. A data analysis plan draft will be developed by October 14, 2011. Locations will also be analyzed in a GIS environment to help characterize their relation to bottom topography, cold- and warm-water gyres (as identified by TOPEX/Poseidon), AVHRR sea surface temperature data, and SeaWiFS chlorophyll data, as well as water depth and distance from shore.

## **Conclusion**

The tagging undertaken by this project will provide information that may be helpful in evaluating possible impacts of the Deepwater Horizon oil spill on sperm whales (and possibly their prey species, squids) in the northern Gulf of Mexico. In addition to assessing whale home range core areas and site tenacity, information regarding dive depths and foraging behavior and the extent to which they coordinate these in their long-term social aggregations will be provided.

## **Data Handling**

Copies of data collected for this plan will be provided to the Trustees through NOAA and to BP upon request. NRDA chain of custody procedures will be observed at all times for all data and samples, including transfers with appropriate chain of custody forms.

All field and laboratory data will be collected, managed and stored in a secure facility in accordance with written SOPs. The appropriate training on particular equipment or in the

conduct of specific field studies for all personnel involved with the project shall be documented and those records shall be kept on file for the duration of this project

All materials associated with the collection or analysis of samples under these protocols or pursuant to any approved work plan, except those consumed as a consequence of the applicable sampling or analytical process, must be retained unless and until approval is given for their disposal in accordance with the retention requirements set forth in paragraph 14 of Pretrial Order # 1 (issued August 10, 2010) and any other applicable Court Orders governing tangible items that are or may be issued in MDL No. 2179 IN RE: Oil Spill by the Oil Rig "DEEPWATER HORIZON" (E.D. LA 2010). Such approval to dispose must be given in writing and by a person authorized to direct such action on behalf of the state or federal agency whose employees or contractors are in possession or control of such materials.

NOAA and BP will supply the contractor with appropriate training and forms for sampling protocols, including shipping requirements.

### **Data Sharing**

Each laboratory shall simultaneously deliver raw data, including all necessary metadata, generated as part of this work plan as a Laboratory Analytical Data Package (LADP) to the trustee Data Management Team (DMT), the Louisiana Oil Spill Coordinator's Office (LOSCO) on behalf of the State of Louisiana and to BP (or CardnoENTRIX on behalf of BP). The electronic data deliverable (EDD) spreadsheet with pre-validated analytical results, which is a component of the complete LADP, will also be delivered to the secure FTP drop box maintained by the trustees' Data Management Team (DMT). Any preliminary data distributed to the DMT shall also be distributed to LOSCO and to BP (or CardnoENTRIX on behalf of BP). Thereafter, the DMT will validate and perform quality assurance/quality control (QA/QC) procedures on the LADP consistent with the authorized Analytical Quality Assurance Plan, after which time the validated/QA/QC'd data shall be made available simultaneously to all trustees and BP (or CardnoENTRIX on behalf of BP). Any questions raised on the validated/QA/QC results shall be handled per the procedures in the Analytical Quality Assurance Plan and the issue and results shall be distributed to all parties. In the interest of maintaining one consistent data set for use by all parties, only the validated/QA/QC'd data set released by the DMT shall be considered the consensus data set. In order to assure reliability of the consensus data and full review by the parties, no party shall publish consensus data until 7 days after such data has been made available to the parties. Also, the LADP shall not be released by the DMT, LOSCO, BP or CardnoENTRIX prior to validation/QA/QC absent a showing of critical operational need. Should any party show a critical operational need for data prior to validation/QA/QC, any released data will be clearly marked "preliminary/unvalidated" and will be made available equally to all trustees and to BP (or CardnoENTRIX on behalf of BP).

All analytical and non-analytical data will be provided to BP's designated representatives and all trustees within a reasonable time frame once data are collected, and QA analyses and data entry

procedures are complete, but no later than 45 days after the data are collected for non-analytical data.

### **Deliverables**

A proposed plan for analysis of data will be provided by OSU by October 14, 2011.

OSU will provide a preliminary field report within 45 days of the end of field activities (approximately mid-October).

OSU will provide an interim report on the 2011 data, inclusive of data collected through November 1, 2011, by January 15, 2012.

OSU will provide a final report on the data collected through February 29, 2012 no later than April 30, 2012.

**Proposed Research Budget, Oregon State University (OSU)  
Satellite Tracking of Sperm Whales in the Gulf of Mexico Near the  
Deepwater Horizon Oil Spill  
Bruce Mate, Principal Investigator - July 2011**

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<u>Salaries and Wages</u>	<u>Months</u>	<u>Salary/mo.</u>	
Bruce Mate, Principal Investigator	█	█	55,936
Research Associate	█	█	12,900
Research Assistants	█	█	50,400
Sheri Woods, Program Assistant	█	█	7,092
Martha Winsor, Statistics	█	█	11,994
Thomas Follett, Data Analyst	█	█	17,096
			<hr/> 155,418
 <u>Other Payroll Expenses; Benefits</u>		<u>OPE Rate</u>	
Bruce, Mate, Principal Investigator		█	17,900
Research Associate		█	6,708
Research Assistants		█	28,728
Sheri Woods, Program Assistant		█	4,042
Martha Winsor, Statistics		█	6,237
Thomas Follett, Data Analyst		█	9,061
			<hr/> 72,676
 <u>Total All Salaries and Benefits</u>			<hr/> <b>\$228,094</b> <hr/>

**Services and Supplies**

Argos satellite whale tags (8 @ \$3,400 plus 5 at \$2,700)	40,700
11 GPS/TDR tags with 3 axis accelerometers supplied by alternate sponsor	N/C
Retrofit existing tags for current research project (12 @ \$500 each)	6,000
Argos charges (monitoring/lab data recovery/Tymet)	19,000
GIS, MATLAB, Eon Fusion and analysis software/maps	9,800
Dedicated computer/server for data archive and GIS processing	4,800
Field materials, computer supplies, copying, postage	4,000
Dedicated laptop computer for photo and video processing	3,400
Phone/fax/data acquisition (includes Argos data down-loads and email)	2,800
Lens for digital camera (we already have) plus back-up storage drives	1,900
Photo-ID work (3 helmet cams, waterproof cases, memory, batteries)	1,700
R/T truck transport of RHiB from Oregon to Louisiana	7,000
Shipping and excess baggage	1,000
RHiB on trailer: 30 days @\$200/d	6,000
RHiB and ancillary equipment shipped to mobilization site and return to Oregon	19,500
shipment of acoustic arrays & winches from Seattle to Newport & return after cruise	1,750

high definition video helmet cams (x3)	950
300 mm lens for improved tag photographs	1,600
Veterinary review panel (5 persons)	5,000
Tag team VHF headsets x 5 for tagging crew	600
	<b>\$137,500</b>

**Passive Acoustic sub-contract**

Set-up team and two researchers (and change-out half way through the cruise)	89,500
	<b>\$89,500</b>

**Vessel charter costs**

30 days vessel charter @\$14K/d*	420,000
Fuel @4620/day x 30 days	138,600
small boat charter for GPS/TDR recovery:15 days @ \$2500/d plus \$500 fuel/d	75,000
	<b>\$633,600</b>

**Travel**

R/T airfare Oregon/New Orleans (8 @ \$1,200)-switching 2 halfway thru	9,600
Airfares for two volunteers from overseas (GPS developer and IT specialist)	5,000
R/T van rental: New Orleans/Houma (9 days @\$150/d)	1,350
Per diem: 8 people x 6 days @ \$200/d transit	9,600
5 people x 30 days @ \$60/d for sea pay	9,000
1 person for tag recovery x 20 days motel & per diem @ \$250	5,000
Local travel (Newport to Corvallis, Eugene, Portland)	1,500
Analysis planning, reporting and presentations	9,000
	<b>\$50,050</b>

**Total Direct Costs (TDC)** **1,138,744**

**OSU Indirect Costs @ [redacted] \* on direct costs (-vessel costs)  
and the first \$25,000 of the  
subcontract**

**OSU Indirect on Vessel Costs @ [redacted]**

**Total Budget** **\$1,501,769**

### **Cost Estimate**

The Parties acknowledge that this budget is an estimate, and that actual costs may prove to be higher. BP's commitment to fund the costs of this work includes any additional reasonable costs within the scope of this approved work plan that may arise. The trustees will make a good faith effort to notify BP in advance of any such increased costs.

Some equipment needed for this study may be in BP's existing inventory, BP-owned equipment will be used if available and when appropriate to the needs of the proposed work.

### **Budget Justification**

**Salaries, Wages, and Other Payroll Expenses** are based on actual amounts for specified employees. Research Associate, Research Assistants and Secretary are based on estimated salaries and OPE from OSU's published table. Secretarial help is requested specifically because Dr. Mate's involvement with the field research will require extra administrative support at OSU to handle routine and emergency matters regarding to the operations of the Marine Mammal Institute. Salaries include field research for approximately [REDACTED], satellite tracking from OSU base of operations, statistical and spatial analysis and reporting.

**Services and Supplies are based on published fees and historical data.** Satellite tag costs are from the OSU published fee book for whale telemetry tags. Retrofitting costs reflect upgrading existing tags to meet requirements for this research. Laptop computer and server are for analyzing photo and satellite data. Cost of digital camera and storage drives are based on current market prices.

**Vessel Charter.** The vessel MS Sarah Bordelon has been chartered for implementation of this Plan.

**Travel** is based on current pricing for airfare to New Orleans, refundable tickets, late booking due to possible changes in scheduling for natural (weather and whales) and organization changes. Travel per diem is at OSU approved rates. Transit costs are estimated. Sea pay is at Marine Mammal Institute's rate of \$60/day.

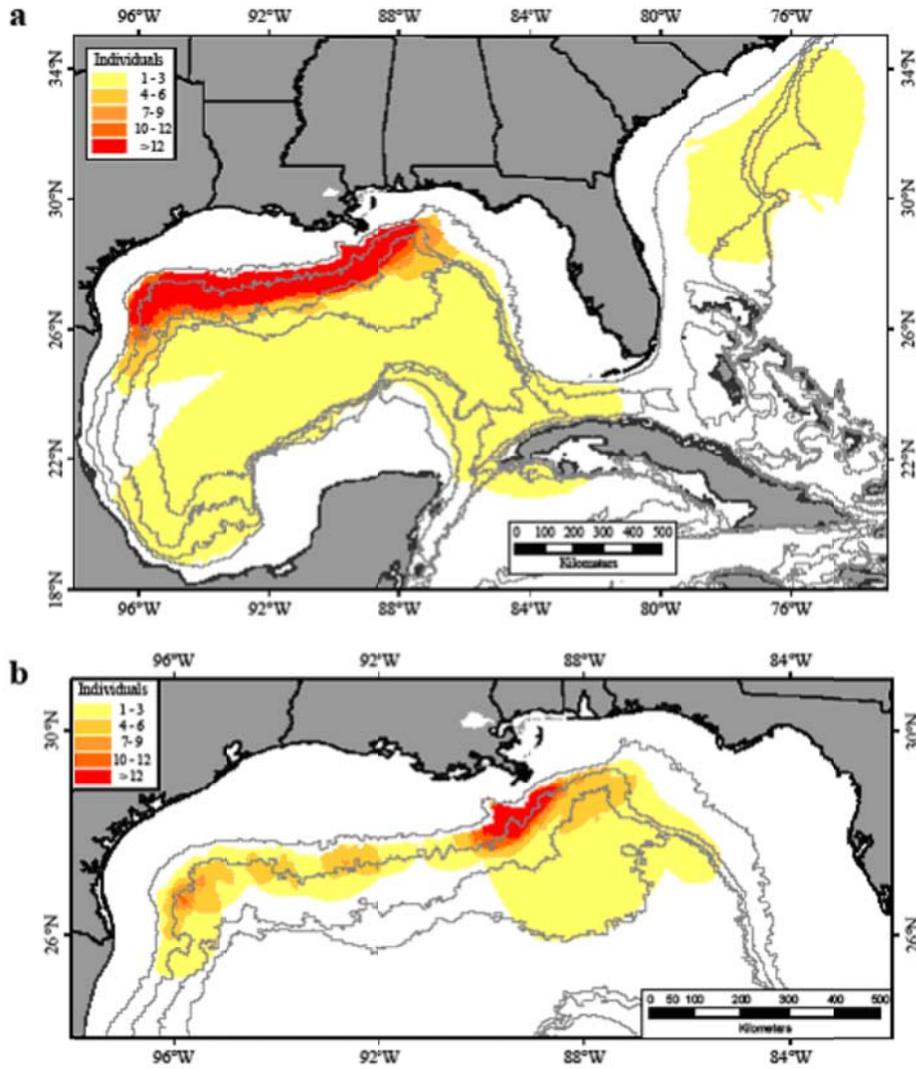


Figure 1: a. 95% kernel home range of all sperm whales tagged during SWSS. b. 50% core area of all sperm whales tagged during SWSS. These areas represent the smallest polygons where whales were found either 95% of the time (kernel home range) or 50% of the time (core area) for the subset of the sperm whale population tagged during SWSS.