ACCESS NUMBER: 15958

STUDY TITLE: Sperm Whale Acoustic Monitoring Program (SWAMP)

REPORT TITLE: Cooperative Research to Study Dive Patterns of Sperm Whales in the Atlantic Ocean

CONTRACT NUMBER: Inter-agency Agreement 15958

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Atlantic Ocean

FISCAL YEAR OF PROJECT FUNDING: 2003

COMPLETION DATE OF REPORT: May 2007

COST: FY 2003: $320K

PROJECT COST: $320K

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KEY WORDS: Atlantic; DTAG; abundance estimate; dive patterns; social structure; sperm whales; habitat preference

BACKGROUND: The National Marine Fisheries Service (NMFS) is required to produce stock assessments for all marine mammal stocks within the U.S. Exclusive Economic Zone. The Minerals Management Service (MMS) is evaluating potential environmental impacts of offshore oil and gas activities on marine mammals. Both agencies have a need for similar information on sperm whales and this is the basis for the cooperative research outlined here.

OBJECTIVES: The objectives are to: 1) collect dive patterns of sperm whales in the Atlantic Ocean to compare to the dive patterns and social structure of sperm whales in the Gulf of Mexico, 2) use the dive patterns to improve abundance estimates of sperm whales, and 3) collect physical and biological habitat data to be used to define habitats of sperm whales in the Atlantic Ocean.

DESCRIPTION: During the July 2003 cruise, scientists from National Marine Fisheries Service (NMFS) and Woods Hole Oceanographic Institution (WHOI) simultaneously conducted line-transect marine mammal visual, passive acoustic, oceanographic, and

plankton (chlorophyll-a) surveys. Satellite data on chlorophyll-a and sea surface temperature were also collected. When concentrations of sperm whales were located, DTAGs were placed on the sperm whales to continuously record the acoustic stimulus impinging on the sperm whale, hydrostatic pressure, water temperature, and the animal's pitch, roll, and compass heading. When animals were tagged, photographs were taken for photo-id studies, biopsy and skin samples were collected for genetic analyses, and visual behavioral studies were conducted.

SIGNIFICANT CONCLUSIONS: We found that the North Atlantic sperm whales followed a foraging and socializing cycle similar to that seen for the Gulf of Mexico whales, but North Atlantic sperm whales dove significantly deeper when foraging. Depending on the reason for the large number of tagged whales that breached, this factor could make an Atlantic study area problematic for future controlled exposure trials with an air-gun source. Areas in the Atlantic where there is a substantial amount of low frequency impulsive sounds from underwater explosions in Navy test ranges, such as off Virginia, should not be considered as a future controlled exposure study areas. The tagged sperm whales spent 27% (CV=0.46) of their time in the surface waters where they could possibly be detected by a visual line transect sighting survey team. Overlays of locations of sperm whales on five-day composites of sea surface temperature (SST) and chlorophyll-a (chl-a) derived from satellite pictures showed that sperm whales appear to be present in more diverse combinations of SST and chl-a than many of the other cetacean species seen. This could mean that they are not cueing in on these two parameters because they are generalists or that they cue on other factors, such as bottom characteristics, rather than surface characteristics.

STUDY RESULTS: Atlantic sperm whales foraged mainly at 500-1100 m but some foraging could have been in water as shallow as 300 m. A wide range of codas were produced. Even fairly closely located groups appeared to prefer distinct codas. An unusually high rate of breaching, possibly associated with tag attachment, limited the longevity of the tag. The maximum attachment duration of six hours in the Atlantic study area compares unfavorably with 16 hours in the Gulf of Mexico and Mediterranean.

Acoustic data could potentially be used in two ways to improve sperm whale abundance estimates. Visual and acoustic data collected during the search mode in this cruise could be used as a test case to develop and test new analytical methods that combine visual and passive acoustic data with the goal to obtain an improved abundance estimate.

Another way acoustic data could be used to improve visual line-transect abundance estimates is to use the dive time pattern data collected on the acoustic tag (DTAG) in surfacing-based line-transect analysis methods. The tagged Atlantic sperm whales spent 27% (CV=0.46) of their time in the surface waters where they could possibly be detected by a visual line transect sighting survey team. Using an over-simplified method of combining traditional line transect data based on groups of whales and the percent of time individual whales spent on the surface, the dive time corrected total

abundance of sperm whales would then be 14,922 (CV=0.60), which is about 3.5 times greater than the visual abundance estimate. However, this abundance estimate is biased upwards for several reasons. Thus, surface-based, not group-based, line-transect analysis methods are under development.

A way to describe the habitat of Atlantic sperm whales is to use Generalized Additive Models (GAM) to model the distribution and abundance of sperm whales with respect to physical and biological parameters, such as water depth, bottom slope, sea surface temperature, salinity at the surface, mixed layer depth, surface color (primary productivity), and distribution and abundance of other trophic levels (such as that found in bongo net samples). Such a model could also include nuisance variables, such as Beaufort sea state, which effects the sightability of the whales, but probably not the actual distribution of whales. Because this cruise did not survey within many types of potential habitats, these data will be combined with large-scale line transect abundance surveys conducted by the NEFSC in 1998 and 2004 to investigate habitat preferences of Atlantic sperm whales. To initiate this investigation, the 1998 data were used with a stepwise GAM and found that depth and an interaction between two groups of plankton species (groups II and III) were the best predictors for the location of Atlantic sperm whales. Locations of sperm whales were negative associated with the location of Plankton group III, which are species generally associated with warm core rings, and positively associated with Plankton group II, which are species most often associated with cooler waters, such as those on the outside edge of a ring or in between warm core rings. Thus, these GAM results can be interpreted as Atlantic sperm whales are most commonly found in waters approximately 2000 meters deep, when those waters are cool, like those found on the outside of or in between warm core rings.

STUDY PRODUCTS: National Marine Fisheries Service and Woods Hole Oceanographic Institution. 2007. Cooperative research to study dive patterns of sperm whales in the Atlantic Ocean. OCS Study MMS 2007-033. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. Inter-agency Agreement 15958-7.

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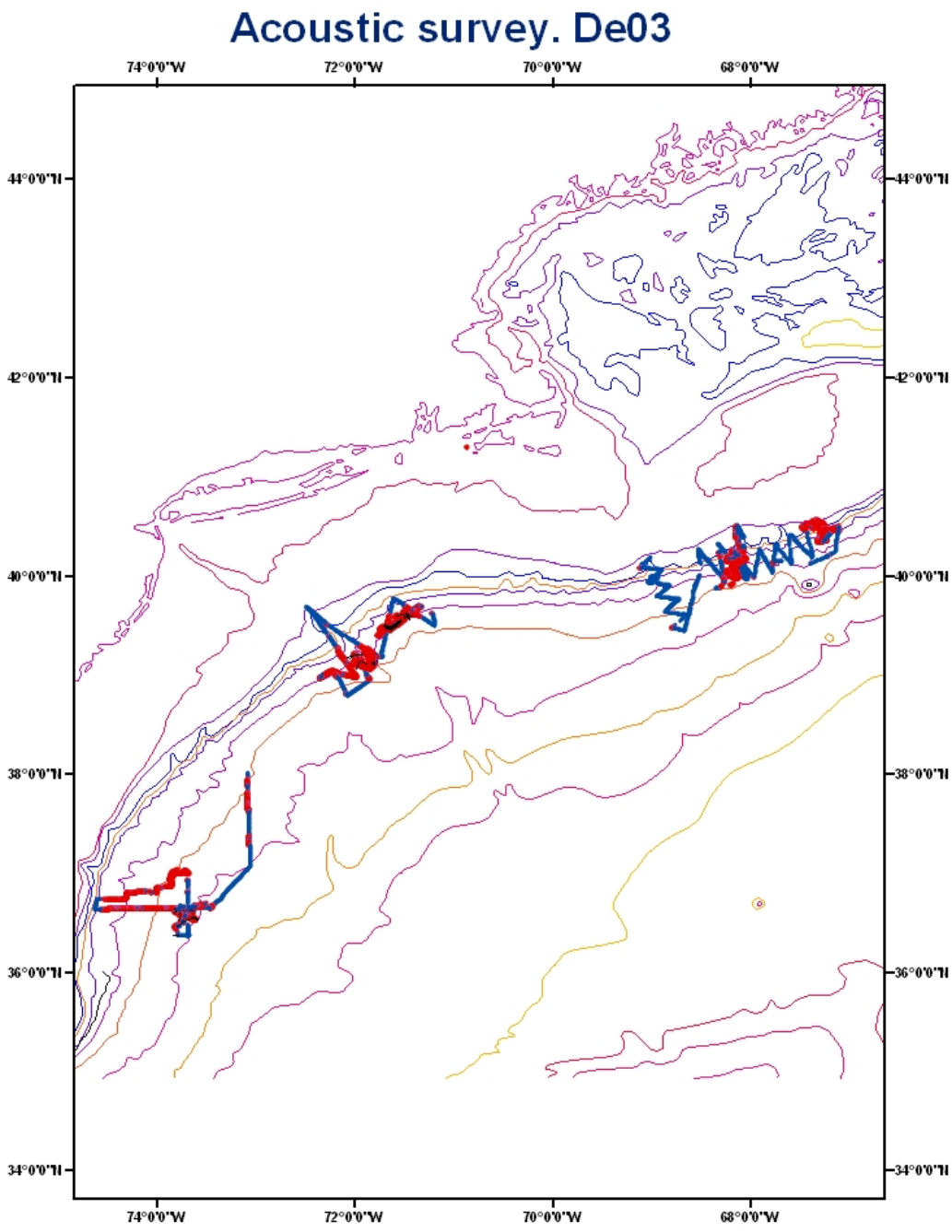

Track lines surveyed in the 2003 cooperative cruise to research dive patterns of sperm whales in the Atlantic Ocean.