

STUDY TITLE: Trophic Aspects of Sperm Whales in the Northern Gulf of Mexico Using Stable Isotopes of C and N: Geographical and Inter-Annual Variation

REPORT TITLE: Trophic Aspects of Sperm whales (*Physeter macrocephalus*) in the Northern Gulf of Mexico using Stable Isotopes of Carbon and Nitrogen

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BACKGROUND: Geophysical exploration and oil and gas development have been moving into the offshore deepwater zone of the northern Gulf of Mexico (GoM) since 1985, a zone that overlaps with sperm whale distribution. Optimal diet is crucial for endangered species as it may affect reproductive success, especially for those species and populations inhabiting areas where anthropogenic activities are increasing. However, in the northern GoM, very little is known about the feeding ecology of sperm whales and potential effects of the energy industry on sperm whale feeding success. Due to the importance of understanding these aspects, the Minerals Management Service supported this study to provide initial information on the variability in the relative trophic position of sperm whales in the northern GoM from 2002 to 2005.. Stable isotopes ratios of carbon (C) and nitrogen (N) from free-ranging sperm whale skin samples were measured as a non-invasive method to evaluate changes in trophic position at different temporal and spatial scales. The $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ ratios from skin samples of sperm whales and muscle samples of cephalopods indicate a relative trophic position that depends on their assimilated diet.

OBJECTIVES: (1) To quantify $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in skin samples of free-ranging sperm whales and investigate interannual variation in their relative trophic position, (2) to

investigate changes in their relative trophic position between two sites in the GoM (Mississippi Canyon and the Northwestern GoM) , and (3) to evaluate the importance of mesopelagic squid species as potential prey of sperm whales.

DESCRIPTION: This study used skin tissue samples of free-ranging sperm whales obtained from 2002 to 2005 in the northern Gulf of Mexico (GoM). These tissue samples were mainly collected for a genetic study as part of the Sperm Whale Seismic Study (SWSS). In the present study, we used available skin samples to investigate aspects of the feeding ecology of this odontocete species using stable isotope analysis. The skin tissue samples used in this study were collected in 2002, 2003 and 2004 in the Mississippi Canyon and in 2005 in the Northwestern Gulf of Mexico. In 2003, muscle tissue samples from a few mesopelagic cephalopods were also obtained at night using 14.8 m² Isaacs-Kidd midwater trawls in areas where sperm whales were observed. Stable isotope ratios of carbon and nitrogen were measured from whale skin and from muscle tissue samples of cephalopods; the isotopic signature of both whales and squid represent a relative trophic position derived from their assimilated diet. Whale gender was determined using molecular analysis based up the ZFX/ZFY technique. We also compared the isotopic values between individuals from the GoM (energy industry activity) and Gulf of California (no energy industry activity), and between squid from inshore and offshore areas within the northern GoM.

SIGNIFICANT CONCLUSIONS: The isotopic ratios of sperm whales from the northern Gulf of Mexico (GoM) were significantly lower by 7.41 ‰ for $\delta^{15}\text{N}$ and 2.74 ‰ for $\delta^{13}\text{C}$ compared to ratios from the Gulf of California (GC). Assuming that 3 ‰ for $\delta^{15}\text{N}$ equals one trophic level, these differences suggest that whales from the GoM would be 2.5 trophic levels lower than whales from the GC. However, geographic variation in baseline isotopic signatures could be responsible for the observed differences. Inferences about trophic position using stable isotopes in studies that lack samples at the base of the food web can be misleading. Further research is needed to distinguish the factors driving this isotopic variation. For example, more effort is needed to collect and analyze samples from mid-water cephalopods as well as from plankton concurrent with tissue samples of sperm whales and squid to determine trophic level and their changes through time. This is crucial to distinguish (1) if sperm whales from the northern Gulf have a lower trophic level than whales from the Gulf of California or (2) if the variability in the biochemical cycle of N and C between areas is responsible for the observed spatial isotopic variation.

STUDY RESULTS: Since isotopic signatures represent a relative trophic position of sperm whales, no differences between females from the Mississippi Canyon (MC) and the northwest Gulf (NW) may suggest that whales feed on similar diet between these two sites or on different prey from the same trophic level. Yet, the number of samples collected in the NW area represents only one year of collection compared with three years for the Mississippi Canyon. Mesopelagic squid from the family Ommastrephidae, such as *Ommastrephes bartramii*, and squid from the family Histiotheutidae were identified as potential prey of sperm whales, although a more representative sample of these squid species for each area (i.e., Mississippi Canyon and NW), including larger-

sized squid, is needed to evaluate this relationship. We documented significant spatial isotopic variability in squid between inshore and offshore sites within the northern Gulf; this variation has important implications for evaluating trophic relationships between predators and prey using stable isotope analysis.

In the GoM, immature males had lower isotopic signatures than females. These results differed from previous studies in the Gulf of California (GC). In the latter area, immature males were higher in $\delta^{15}\text{N}$ than females. This difference can be associated with length and age of immature males, range of foraging areas (horizontal and vertical) and prey size consumed. Comparable $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values among years indicate that sperm whales maintained a similar diet composition throughout the period from 2002 to 2005. We recommend continued investigation of the feeding ecology of free-ranging whales by using stable isotope ratios in association with mesopelagic cephalopods.

STUDY PRODUCT: Ruiz-Cooley R. I. and D. T. Engelhaupt. Trophic Aspects of Sperm Whales (*Physeter macrocephalus*) in the Northern Gulf of Mexico Using Stable Isotopes of Carbon and Nitrogen Report. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA, OCS Study MMS 2010-016, 28 pp.

Reference values of isotopic ratios ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) in sperm whale skin samples collected from 2002 to 2005