SPERM WHALE (*Physeter macrocephalus*): Northern Gulf of Mexico Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sperm whales are found throughout the world's oceans in deep waters from the tropics to the edge of the ice at both poles (Leatherwood and Reeves 1983; Rice 1989; Whitehead 2002). Sperm whales were commercially hunted in the Gulf of Mexico by American whalers from sailing vessels until the early 1900s (Townsend 1935). In the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico) systematic aerial and ship surveys indicate that sperm whales inhabit continental slope and oceanic waters where they are widely distributed (Figure 1; Fulling *et al.* 2003; Mullin and Fulling 2004; Mullin *et al.* 2004; Maze-Foley and Mullin 2006; Mullin 2007). Seasonal aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons (Mullin *et al.* 1994; Hansen *et al.* 1996; Mullin and Hoggard 2000).

Because there are many confirmed records from Gulf of Mexico waters beyond U.S. boundaries (e.g., Jefferson and Schiro 1997, Ortega Ortiz 2002), sperm whales almost certainly occur throughout the oceanic Gulf of Mexico (Jefferson *et al.* 2008), which is also composed of waters belonging to Mexico and Cuba where there is currently little information on cetacean species abundance and distribution. U.S. waters comprise about 40% of the entire Gulf of Mexico, and 65% of oceanic waters are south of the U.S. Exclusive Economic Zone (EEZ).

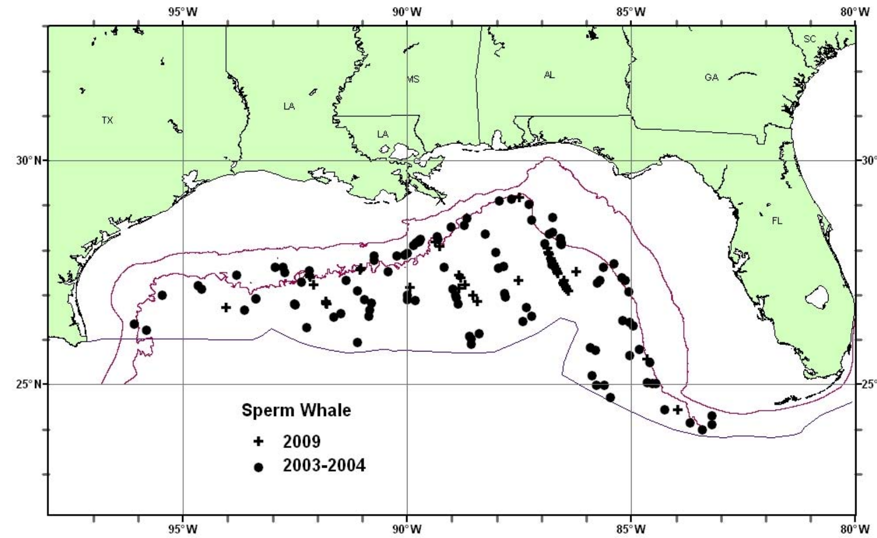

Figure 1. *Distribution of sperm whale sightings from SEFSC vessel surveys during summer 2003 and spring 2004, and during summer 2009. All the on-effort sightings are shown, though not all were used to estimate abundance. Solid lines indicate the 100m and 1,000m isobaths and the offshore extent of the U.S. EEZ.*

Sperm whales throughout the world exhibit a geographic social structure where females and juveniles of both sexes occur in mixed groups and inhabit tropical and subtropical waters. Males, as they mature, initially form bachelor groups but eventually become more socially isolated and more wide-ranging, inhabiting temperate and polar waters as well (Whitehead 2003). While this pattern also applies to the Gulf of Mexico, results of multi-disciplinary research conducted in the Gulf since 2000 confirms speculation by Schmidly (1981) and indicates clearly that Gulf of Mexico sperm whales constitute a stock that is distinct from other Atlantic Ocean stocks(s) (Mullin *et al.* 2003; Jaquet 2006; Jochens *et al.* 2008). The following summarizes the most significant stock structure-related findings from the Sperm Whale Seismic Study (Jochens *et al.* 2008) and associated projects. Measurements of the total length of Gulf of Mexico sperm whales indicate that they are 1.5-2.0m smaller on average compared to whales measured in other areas. Female/immature group size in the Gulf is about one-third to one-fourth that found in the Pacific Ocean but more similar to group sizes in the Caribbean (Richter *et al.* 2008; Jaquet and Gendron 2009). Tracks from 39 whales satellite tagged in the northern Gulf were monitored for up to 607 days. No discernable seasonal migrations were made, but Gulf-wide movements primarily along the northern Gulf slope did occur. The tracks showed that whales exhibit a range of movement patterns within the Gulf, including movement into the southern Gulf in a few cases, but that only 1 whale (a male) left the Gulf of Mexico. This animal moved into the North Atlantic and then back into the Gulf after about 2 months. Additionally, no matches were found when 285 individual whales photo-identified from the Gulf and about 2500 from the North Atlantic and Mediterranean Sea were compared. More recently, Gero *et al.* (2007) suggested that movements of sperm whales between the adjacent areas of the Caribbean Sea, Gulf of Mexico and Atlantic may not be common. No matches were made from animals photo-identified in the eastern Caribbean Sea (islands of Dominica, Guadeloupe, Grenada, St. Lucia and Martinique) with either animals from the Sargasso Sea or the Gulf of Mexico. Engelhaupt *et al.* (2009) conducted an analysis of matrilineally inherited mitochondrial DNA and found significant genetic differentiation between animals from the northern Gulf of Mexico and those from the western North Atlantic Ocean, North Sea and Mediterranean Sea. Analysis of biparentally inherited nuclear DNA showed no significant difference between whales sampled in the Gulf and those from the other areas of the North Atlantic, suggesting that while females show strong philopatry to the Gulf, male-mediated gene flow between the Gulf and North Atlantic Ocean may be occurring (Engelhaupt *et al.* 2009).

Sperm whales make vocalizations called "codas" that have distinct patterns and are apparently culturally transmitted (Watkins and Schevill 1977; Whitehead and Weilgart 1991; Rendell and Whitehead 2001), and based on degree of social affiliation, mixed groups of sperm whales (mixed-sex groups of females/immatures) worldwide can be placed in recognizable acoustic clans (Rendell and Whitehead 2003). Recordings from mixed groups in the Gulf of Mexico compared to those from other areas of the Atlantic indicated that Gulf sperm whales constitute a distinct acoustic clan that is rarely encountered outside of the Gulf. It is assumed from this that groups from other clans enter the northern Gulf only infrequently (Gordon *et al.* 2008). Antunes (2009) used additional data to further examine variation in sperm whale coda repertoires in the North Atlantic Ocean, and found that variation in the North Atlantic is mostly geographically structured as coda patterns were unique to certain regions and a significant negative correlation was found between coda repertoire similarities and geographic distance. His work also suggested sperm whale codas differed between the Gulf of Mexico and the North Atlantic.

POPULATION SIZE

The best abundance estimate available for northern Gulf of Mexico sperm whales is 763 (CV=0.38; Table 1). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. EEZ.

Earlier abundance estimates

Please see Appendix IV for a summary of abundance estimates, including earlier estimates and survey descriptions.

Recent survey and abundance estimate

During summer 2009, a line-transect survey dedicated to estimating the abundance of oceanic cetaceans was conducted in the northern Gulf of Mexico. Survey lines were stratified in relation to depth and the location of the Loop Current. The abundance estimate for sperm whales in oceanic waters during 2009 was 763 (CV=0.38; Table 1).

Table 1. Summary of abundance estimates for northern Gulf of Mexico sperm whales. Month, year and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Apr-Jun 1991-1994	Oceanic waters	530	0.31
Apr-Jun 1996-2001 (excluding 1998)	Oceanic waters	1,349	0.23
Jun-Aug 2003, Apr-Jun 2004	Oceanic waters	1,665	0.20
Jun-Aug 2009	Oceanic waters	763	0.38

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normal distributed abundance estimate. This is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by Wade and Angliss (1997). The best estimate of abundance for sperm whales is 763 (CV=0.38). The minimum population estimate for the northern Gulf of Mexico is 560 sperm whales.

Current Population Trend

A trend analysis has not been conducted for this stock. Four point estimates of sperm whale abundance have been made based on data from surveys covering 1991-2009 (Table 1). The estimates vary by a maximum factor of 3.1. To determine whether changes in abundance have occurred over this period, an analysis of all the survey data needs to be conducted which incorporates covariates (e.g., survey conditions, season) that could potentially affect estimates. It should be noted that since this is a transboundary stock and the abundance estimates are for U.S. waters only, it will be difficult to interpret any detected trends.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of the minimum population size, one half the maximum net productivity rate and a recovery factor (MMPA Sec. 3.16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 560. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.1 because the sperm whale is an endangered species. PBR for the northern Gulf of Mexico sperm whale is 1.1.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The total human-caused mortality and serious injury for sperm whales in the northern Gulf of Mexico during 2009–2013 was 0.

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998; Andersen *et al*. 2008; NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

Fisheries Information

The commercial fishery that interacts with this stock in the Gulf of Mexico is the Atlantic Ocean, Caribbean, Gulf of Mexico large pelagic longline fishery (Appendix III). Pelagic swordfish, tunas and billfish are the targets of the longline fishery operating in the northern Gulf of Mexico. There have been no reports of mortality or serious injury to sperm whales by this fishery in recent years (2009–2013) or historically 1998-2008 (Yeung 1999; 2001; Garrison 2003; Garrison and Richards 2004; Garrison 2005; Fairfield Walsh and Garrison 2006; Fairfield-Walsh and Garrison 2007; Fairfield and Garrison 2008; Garrison *et al.* 2009; Garrison and Stokes 2010; 2012a,b; 2013; 2014). However, in 2008 during quarter 2, there was an entanglement and live release without serious injury of 1 sperm whale (Garrison *et al.* 2009). The whale was entangled in mainline and other gear and was accompanied by a calf. The mainline broke when the whale dove and gear remained on the animal; however, since it was a large whale it was not considered seriously injured (Garrison and Stokes 2008). This was the first observed interaction between a sperm whale and this fishery. During 15 April – 15 June 2008, and also subsequently during the second quarters (15 April – 15 June) of 2009–2013, observer coverage in the Gulf of Mexico pelagic longline fishery was greatly enhanced (approaching 55%) to collect more robust information on the interactions between pelagic longline vessels and spawning bluefin tuna. Therefore, the high annual observer coverage rates during 2008-2013 primarily reflect high coverage rates during the second quarter of each year. During the second quarter, this elevated coverage results in an increased probability that relatively rare interactions will be detected. Species within the oceanic Gulf of Mexico are presumed to be resident year-round; however, it is unknown if the bycatch rate observed during the second quarter is representative of that which occurs throughout the year.

A commercial fishery for sperm whales operated in the Gulf of Mexico in deep waters between the Mississippi River delta and DeSoto Canyon during the late 1700s to the early 1900s (Mullin *et al.* 1991), but the exact number of whales taken is not known (Townsend 1935; Lowery 1974). Townsend (1935) reported many records of sperm whales from April through July in the north-central Gulf (Petersen and Hoggard 1996).

Other Mortality

There were 8 sperm whale strandings in the northern Gulf of Mexico during 2009–2013 (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 11 June 2014). It could not be determined if there was evidence of human interactions for any of the 8 stranded animals. Stranding data probably underestimate the extent of human and fishery-related mortality and serious injury, particularly for offshore species such as sperm whales, because not all of the whales that die or are seriously injured in human interactions wash ashore, or, if they do, they are not all recovered (Peltier *et al*. 2012; Wells *et al*. 2015). Additionally, not all carcasses will show evidence of human interaction, entanglement or other fishery-related interaction due to decomposition, scavenger damage, etc. (Byrd *et al*. 2014). Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of human interaction.

An Unusual Mortality Event (UME) was declared for cetaceans in the northern Gulf of Mexico beginning 1 February 2010; and, as of September 2014, the event is still ongoing (Litz *et al.* 2014). It includes cetaceans that stranded prior to the *Deepwater Horizon* oil spill (see "Habitat Issues" below), during the spill, and after. During 2010-2013, 5 sperm whales from this stock were considered to be part of the UME.

Ship strikes to whales occur world-wide and are a source of injury and mortality. No vessel strikes have been documented in recent years (2009–2013) for sperm whales in the Gulf of Mexico. Historically, 1 possible sperm whale mortality due to a vessel strike has been documented for the Gulf of Mexico. The incident occurred in 1990 in the vicinity of Grande Isle, Louisiana. Deep cuts on the dorsal surface of the whale indicated the ship strike was probably pre-mortem (Jensen and Silber 2004).

HABITAT ISSUES

The *Deepwater Horizon* (DWH) MC252 drilling platform, located approximately 50 miles southeast of the Mississippi River Delta in waters about 1500 m deep, exploded on 20 April 2010. The rig sank, and over 87 days up to ~4.9 million barrels of oil were discharged from the wellhead until it was capped on 15 July 2010 (McNutt *et al.* 2012). During the response effort dispersants were applied extensively at the seafloor and at the sea surface (Lehr *et al.* 2010; OSAT 2010). In-situ burning, or controlled burning of oil at the surface, was also used extensively as a response tool (Lehr *et al.* 2010). The oil, dispersant and burn residue compounds present ecological concerns (Buist *et al.* 1999; NOAA 2011). The magnitude of this oil spill was unprecedented in U.S. history, causing impacts to wildlife, natural habitats and human communities along coastal areas from western Louisiana to the Florida Panhandle (NOAA 2011). It could be years before the entire scope of damage is ascertained (NOAA 2011).

Shortly after the oil spill, the Natural Resource Damage Assessment (NRDA) process was initiated under the Oil Pollution Act of 1990. A variety of NRDA research studies are being conducted to determine potential impacts of the spill on marine mammals. These studies have focused on identifying the type, magnitude, severity, length and impact of oil exposure to oceanic, continental shelf, coastal and estuarine marine mammals. For continental shelf and oceanic cetaceans, the NOAA-led efforts include: aerial surveys to document the distribution, abundance, species and exposure relative to oil from the DWH spill; and ship surveys to evaluate exposure to oil and other chemicals and to assess changes in animal behavior and distribution relative to oil exposure through visual and acoustic surveys, deployment of passive acoustic monitoring systems, collection of tissue samples, and deployment of satellite tags on sperm and Bryde's whales.

Vessel and aerial surveys documented sperm whales, bottlenose dolphins, Atlantic spotted dolphins, rough-toothed dolphins, spinner dolphins, pantropical spotted dolphins, Risso's dolphins, striped dolphins, dwarf/pygmy sperm whales and a Cuvier's beaked whale swimming in oil or potentially oil-derived substances (e.g., sheen, mousse) in the offshore waters of the northern Gulf of Mexico following the DWH oil spill. The effects of oil exposure on marine mammals depend on a number of factors including the type and mixture of chemicals involved; the amount, frequency and duration of exposure; the route of exposure (inhaled, ingested, absorbed, or external); and biomedical risk factors of the particular animal (Geraci 1990). In general, direct external contact with petroleum compounds or dispersants with skin may cause skin irritation, chemical burns and infections. Inhalation of volatile petroleum compounds or dispersants may irritate or injure the respiratory tract, which could lead to pneumonia or inflammation. Ingestion of petroleum compounds may cause injury to the gastrointestinal tract, which could affect an animal's ability to digest or absorb food. Absorption of petroleum compounds or dispersants may damage kidney, liver and brain function in addition to causing immune suppression and anemia. Long-term chronic effects such as lowered reproductive success and decreased survival may occur (Geraci 1990).

Seismic vessel operations in the Gulf of Mexico (commercial and academic) now operate with marine mammal observers as part of required mitigation measures. There have been no reported seismic-related or industry ship-related mortalities or injuries to sperm whales. However, disturbance by anthropogenic noise may prove to be an important habitat issue in some areas of this population's range, notably in areas of oil and gas activities and/or where shipping activity is high. Results from very limited studies of northern Gulf of Mexico sperm whale responses to seismic exploration indicate that sperm whales do not appear to exhibit horizontal avoidance of seismic survey activities (Miller *et al.* 2009). Data did suggest there may be some decrease in foraging effort during exposure to full-array airgun firing, at least for some individuals. Further study is needed as samples sizes are insufficient at this time (Miller *et al.* 2009).

STATUS OF STOCK

The sperm whale is listed as endangered under the Endangered Species Act, and therefore the northern Gulf of Mexico stock is considered strategic under the MMPA. Total human-caused mortality and serious injury for this stock during 2009–2013 was 0. The total fishery-related mortality and serious injury for this stock is insignificant and approaching zero mortality and serious injury rate. The status of sperm whales in the northern Gulf of Mexico, relative to OSP, is unknown. There are insufficient data to determine the population trends for this stock.

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