SPERM WHALE (*Physeter macrocephalus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The sperm whale is reported during all four seasons along the continental shelf edge in the northeastern U.S. Atlantic coast Exclusive Economic Zone (EEZ) (CeTAP 1982). These data as well as observations in the literature suggest that the distribution of the sperm whale continues well beyond the continental shelf edge, over the continental slope, and into mid-ocean regions (Fig. 1). Waring et al. (1993) suggest that this offshore distribution is more commonly associated with the Gulf Stream edge and other features. In the shoreward direction, Hain and Kenney (unpublished data) report an occurrence on the continental shelf from August through November inshore of the 100m depth contour south of New England and on the southern Scotian Shelf.

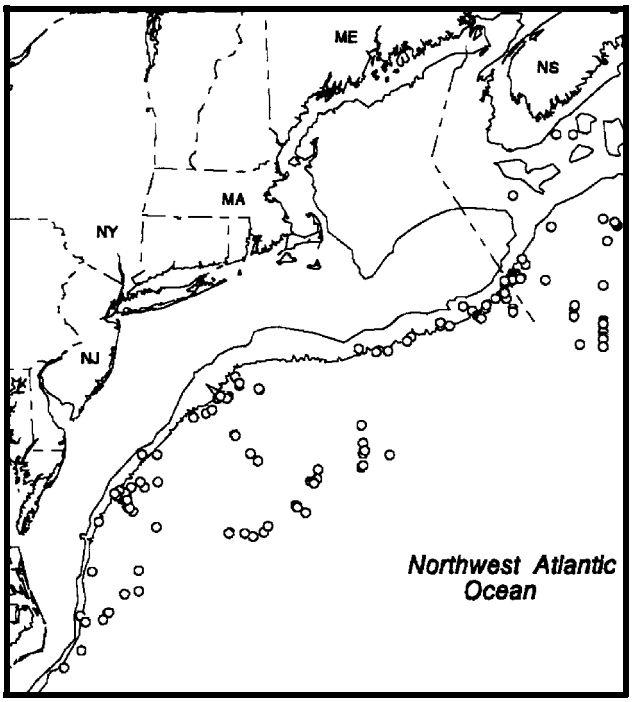

Figure 1. *Distribution of sperm whale sightings from NEFSC shipboard surveys during the summer in 1990-1994. Isobaths are at 100 m and 1,000 m.*

There appears to be a distinct seasonal cycle. In winter, sperm whales are concentrated east and northeast of Cape Hatteras. In spring, the center of distribution shifts northward to east of the Delmarva peninsula, and is widespread throughout the central portion of the mid-Atlantic bight and the southern portion of Georges Bank. In summer, the distribution is similar but now also includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest level, and there remains a continental shelf edge occurrence in the mid-Atlantic bight.

The sperm whales that occur in the eastern U.S. EEZ likely represent only a fraction of the total stock, perhaps at a lateral periphery of the entire range. The nature of linkages of this habitat with those to the south, north, and offshore is unknown. Historical whaling records compiled by Schmidly (1981) suggest an offshore distribution off the southeast U.S., over the Blake Plateau, and offshore in the deep ocean. In the southeast Caribbean, both large and small adults, as well as calves and juveniles of different sizes are reported (Watkins et al. 1985).

Geographic distribution of sperm whales may be linked to their social structure and their low reproductive rate and both of these factors have management implications. Several basic groupings or social units are generally recognized — nursery schools, harem or mixed schools, juvenile or immature schools, bachelor schools, bull schools or pairs, and solitary bulls (Best 1979). These groupings have a distinct geographical distribution, with females and juveniles generally based in tropical and subtropical waters, and males more wide-ranging and occurring in higher latitudes. The basic social unit of the sperm whale appears to be the mixed school of adult females plus their calves and some juveniles of both sexes, normally numbering 20-40 animals in all. There is evidence that some social bonds persist for many years. Sperm whales have a very low reproductive rate, probably the lowest recorded for any marine mammal to date. The gestation period is estimated at 14-16 months, with a 5-year reproductive cycle.

POPULATION SIZE

The total numbers of sperm whales off the U.S. or Canadian Atlantic coast are unknown, though several estimates from selected regions of the habitat do exist. Seasonal abundance estimates are available from an aerial

survey program conducted in continental shelf and continental shelf edge waters between Cape Hatteras, North Carolina, and Nova Scotia from 1978 to 1982 (CeTAP 1982). An estimate based on an inverse variance weighted pooling of CeTAP (1982) spring and summer data is 219 (CV = 0.36). An average for these two seasons was chosen because the greatest proportion of the population off the northeast U.S. coast appears to be in the CeTAP study area in these seasons. The data were analyzed using DISTANCE (Buckland et al. 1993; Laake et al. 1993), where the confidence interval was calculated using the bootstrap log normal method. This estimate was not corrected for g(0), the probability of detecting an animal group on the trackline.

Abundance estimates were also derived using data collected during an autumn 1991 line transect aerial survey in the CeTAP study area (NMFS unpublished data), which included an interplatform experiment between a Twin Otter and an AT-11), and from four fine-scale shipboard line transect surveys (August 1990, June-July 1991, June-July 1993, and August 1994) conducted in continental shelf edge and deeper oceanic waters (NMFS unpublished data). For both the aerial and shipboard surveys, sightings were almost exclusively in the continental shelf edge and continental slope areas. The 1991 aerial survey repeated many of the CeTAP-defined survey blocks, and added several continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. Abundance estimates from this 1991 aerial survey were 337 (CV = 0.50) and 705 (CV = 0.66) for the AT-11 and NOAA Twin Otter, respectively. Data were not pooled, because the interplatform calibration analysis has not been conducted. Furthermore, these estimates are not fully comparable to the CeTAP estimates, because the 1991 data are from a single survey, August to October, while the CeTAP estimates were based on data pooled over several years of seasonal surveys.

An abundance estimate from the August 1990 shipboard survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank, is 338 (CV = 0.31). The 1991 shipboard survey estimate, based principally on sighting effort conducted between the 200 and 2,000 meter isobaths from Cape Hatteras to Georges Bank is 736 (CV = 0.36). The estimate for the 1993 survey, conducted principally between the 200 and 2,000 meter isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf is 116 (CV = 0.40). The 1994 estimate, based on survey effort within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank is 623 (CV = 0.52).

Because the estimates presented here were not dive-time corrected, they are likely downwardly biased and an underestimate of actual abundance. Given that the average dive-time of sperm whales is 45 min (W. A. Watkins, personal communication), the bias may be substantial.

Although the stratification schemes used in the 1990-1994 surveys did not always sample the same areas or encompass the entire sperm whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990-94 data suggest that, seasonally, at least several hundred sperm whales are occupying these waters, with perhaps greater abundances in the mid Atlantic region. This is consistent with the earlier CeTAP data from a decade previous. Sperm whale abundance may increase offshore, particularly in association with Gulf Stream and warm-core ring features; however, at present there is no reliable estimate of total sperm whale abundance in the western North Atlantic.

Minimum Population Estimate

The minimum population estimate was based on the AT-11 aerial survey population estimate in autumn 1991 of 337 sperm whales (CV = 0.50). This estimate was selected because the AT-11 survey provided the most complete coverage of continental shelf edge and continental slope waters off the northeast U.S. coast. The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distribution as specified by NMFS (Anon. 1994), and was 226 sperm whales.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

While more is probably known about sperm whale life history in other areas, some life history and vital rates information is available for the northwest Atlantic. Some of the life history parameters which have been estimated include: calving interval is 3-4 years, lactation period is 24 months, gestation period is 14.5-16.5 months, births occur

mainly in July to November, length at birth is 405 cm, length at sexual maturity 11.0-12.0 m for males, and 8.3-9.2 m for females, mean age at sexual maturity is 19 years for males and 9 years for females, and mean age at physical maturity is 45 years for males and 30 years for females (Best 1974; Lockyer 1981).

Current and maximum net productivity rates for this stock are not known. The maximum net productivity rate was assumed to be 0.04 for purposes of this assessment. This value is based on theoretical calculations showing that cetacean populations may not generally grow at rates much greater than 4% given the constraints of their reproductive life history (Anon. 1994).

POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) was specified as the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor is 0.10 because this species is listed as endangered under the Endangered Species Act (ESA). PBR for this stock is 0.5 sperm whales.

ANNUAL HUMAN-CAUSED MORTALITY

Four hundred twenty-four sperm whales were taken in the Newfoundland-Labrador area between 1904-1972 and 109 sperm whales were taken near Nova Scotia in 1964-1972 (Mitchell and Kozicki 1984) in a Canadian fishery. There was also a well-documented sperm whale fishery based on the west coast of Iceland. Other sperm whale catches occurred near West Greenland, the Azores, Madeira, Spain, Spanish Morocco, Norway (coastal and pelagic), Faroes, and British coastal. Whether the northwest Atlantic population is discrete from those fished elsewhere in the northwestern or northeastern Atlantic is currently unresolved. There exists one tag return of a male tagged off Browns Bank (Nova Scotia) in 1966 and returned from Spain in 1973. At present, because of their general offshore distribution, sperm whales are less likely to be impacted by humans and those impacts that do occur are less likely to be recorded. There has been no complete analysis and reporting of existing data on this topic for the western North Atlantic. Only a single record exists in the present NEFSC by-catch database. In July 1990, a sperm whale was entangled and subsequently released (injured) from a swordfish drift net near the continental shelf edge on southern Georges Bank.

Total annual estimated average fishery-related mortality and serious injury to this stock in the U.S. Atlantic EEZ during 1989-1993 was 1.6 sperm whales (CV = 2.72). There is no information on incidental mortality in fisheries in Canadian waters. Total fishery-related mortality and serious injury for this stock is greater than 10% of the calculated PBR, based on limited survey data, and cannot be considered insignificant and approaching zero mortality and serious injury rate. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

Fishery Information

The estimated total number of hauls in the Atlantic large pelagic drift gillnet fishery increased from 714 in 1989 to 1144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, and 1993 were 233, 243, and 232 respectively. Fifty-nine vessels participated in this fishery between 1989 and 1993. Observer coverage, percent of sets observed, ranged from 8% in 1989, 6% in 1990, 20% in 1991, to 40% in 1992 and 42% in 1993. The greatest concentrations of effort were located along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. One sperm whale was entangled in this fishery and released showing signs of serious injury. Annual fishery-related mortality and serious injury was estimated using the aggregated catch rates, by strata (Northridge, in review). Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 2.2 sperm whales in 1989 (2.43), 4.4 in 1990 (1.77), 0.5 in 1991 (1.49), 0.4 (1.44) in 1992, and 0.3 (1.37) in 1993.

STATUS OF STOCK

The status of this stock relative to OSP is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends. The current stock abundance estimate was based upon a small portion of the known stock range within the U.S. EEZ. This is believed to be an underestimate and estimates of stock size based on surveys of the entire range are expected to result in a higher calculated PBR. This is a strategic

stock because the species is listed as endangered under the ESA and estimated annual fishery-related mortality and serious injury exceeds PBR

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