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SPERM WHALE (*Physeter macrocephalus*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sperm whales are widely distributed across the entire North Pacific and into the southern Bering Sea in summer but the majority are thought to be south of 40°N in winter (Rice 1974, 1989; Gosho et al. 1984; Miyashita et al. 1995). For management, the International Whaling Commission (IWC) had divided the North Pacific into two management regions (Donovan 1991) defined by a zig-zag line which starts at 150°W at the equator, is 160°W between 40-50°N, and ends up at 180°W north of 50°N; however, the IWC has not reviewed this stock boundary in many years (Donovan 1991). Summer/fall surveys in the eastern tropical Pacific (Wade and Gerrodette 1993) show that although sperm whales are widely distributed in the tropics, their relative abundance tapers off markedly westward towards the middle of the tropical Pacific (near the IWC stock boundary at 150°W) and tapers off northward towards the tip of Baja California. The Hawaiian Islands marked the center of a major nineteenth century whaling ground for sperm whales (Gilmore 1959; Townsend 1935). Since 1936, at least 18 strandings have been reported from Oahu, Kauai and Kure Atoll (Woodward 1972; Nitta 1991; Maldini 2005). Sperm whales have also been sighted around several of the Northwestern Hawaiian Islands (Rice 1960; Barlow 2003), off the main island of Hawaii (Lee 1993; Mobley et al. 2000) in the Kauai Channel and in the Alenuihaha Channel between Maui and the island of Hawaii (Shallenberger 1981). In addition, the sounds of sperm whales have been recorded throughout the year off Oahu (Thompson and Friedl 1982). A summer/fall 2002 shipboard survey of waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands resulted in 43 sperm whale sightings throughout the study area (Figure 1; Barlow 2003).

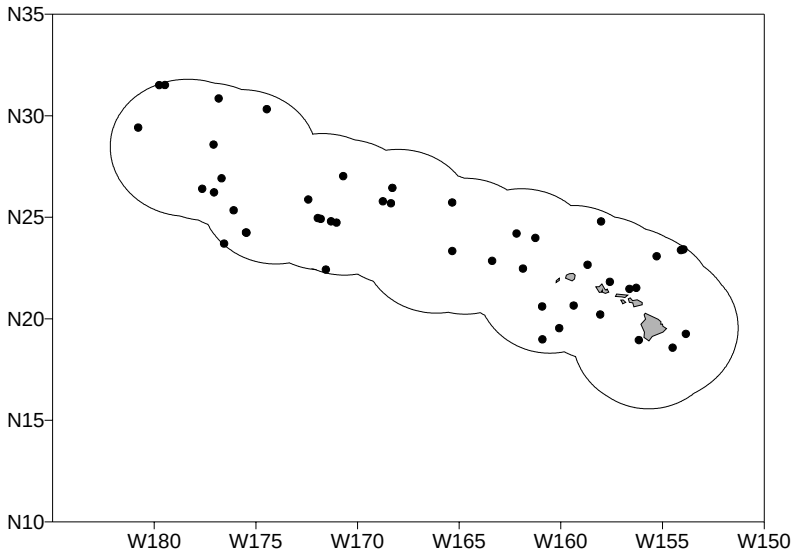

Figure 1. Sperm whale sighting locations during the 2002 shipboard survey of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2003; see Appendix 2 for details on timing and location of survey effort). Outer line represents approximate boundary of survey area and U.S. EEZ.

The stock identity of sperm whales in the North Pacific has been inferred from historical catch records (Bannister and Mitchell 1980) and from trends in CPUE and tag-recapture data (Ohsumi and Masaki 1977), but much uncertainty remains. A 1997 survey designed specifically to investigate stock structure and abundance of sperm whales in the northeastern temperate Pacific revealed no apparent hiatus in distribution between the U.S. EEZ off California and areas farther west, out to Hawaii (Barlow and Taylor 1998). Very preliminary genetic analyses revealed significant differences between sperm whales off the coast of California, Oregon and Washington and those sampled offshore to Hawaii (Mesnick et al., unpubl. data); analyses of additional genetic samples are ongoing at the NMFS, Southwest Fisheries Science Center. For the Marine Mammal Protection Act (MMPA) stock assessment reports, sperm whales within the Pacific U.S. EEZ are divided into three discrete, non-contiguous areas: 1) waters around Hawaii (this report), 2) California, Oregon and Washington waters, and 3) Alaskan waters.

POPULATION SIZE

A large 1982 abundance estimate for the entire eastern North Pacific (Gosho et al. 1984) was based on a CPUE method which is no longer accepted as valid by the International Whaling Commission. A spring 1997 combined visual and acoustic line-transect survey conducted in the eastern temperate North Pacific resulted in estimates of 24,000 (CV=0.46) sperm whales based on visual sightings, and 39,200 (CV=0.60) based on acoustic detections and visual group size estimates (Barlow and Taylor 1998). In the eastern tropical Pacific, the abundance of sperm whales has been estimated as 22,700 (95% C.I.=14,800-34,600; Wade and Gerrodette 1993). However, it

is not known whether any or all of these animals routinely enter the U.S. EEZ of the Hawaiian Islands. As part of the Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study, a total of twelve aerial surveys were conducted within about 25 nmi of the main Hawaiian Islands in 1993, 1995 and 1998. An average abundance estimate of 66 (CV=0.56) sperm whales was calculated from the combined survey data (Mobley et al. 2000). This study underestimated the total number of sperm whales within the U.S. EEZ off Hawaii, because areas around the Northwestern Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed. Furthermore, this species is known to spend a large proportion of time diving, causing additional downward bias in the abundance estimate. The data on which this estimate was based are now over 5 years old. A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 7,082 (CV=0.30) sperm whales (Barlow 2003), including a correction factor for missed diving animals. This is currently the best available abundance estimate for this stock.

Minimum Population Estimate

The log-normal 20th percentile of the 2002 abundance estimate is 5,531 sperm whales.

Current Population Trend

No data on current population trend are available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data on current or maximum net productivity rate are available.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (5,531) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (the default value for an endangered species; Wade and Angliss 1997), resulting in a PBR of 11 sperm whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Information on fishery-related mortality of cetaceans in Hawaiian waters is limited, but the gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets appear to capture marine mammals wherever they are used, and float lines from lobster traps and longlines can be expected to occasionally entangle whales (Perrin et al. 1994).

Interactions with cetaceans are reported for all pelagic fisheries, and large whales have been entangled in longlines off the Hawaiian Islands (Nitta and Henderson 1993; NMFS/PIR, unpublished data). Between 1994 and 2002, one sperm whale was observed entangled within the Hawaiian Islands EEZ in the Hawaii-based longline fishery, with approximately 4-25% of all effort observed (Table 1; Forney 2004). During the 905 observed trips with 11,014 sets, the average interaction rate of sperm whales was one animal per 905 fishing trips, or one animal per 11,014 sets. The

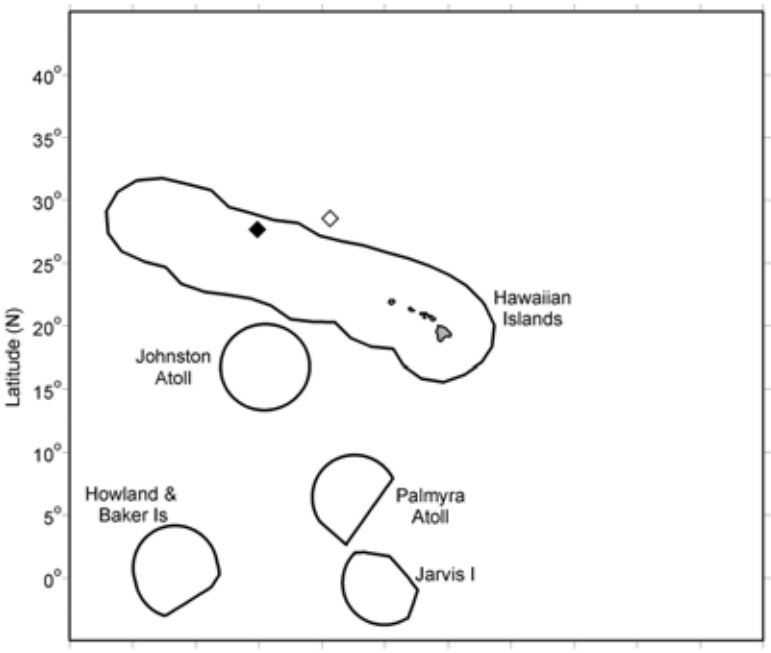

Figure 2. Location of the observed sperm whale take in the Hawaii-based longline fishery, 1998-2002 (filled diamond), and the take observed during an experimental longline set in 2002 (open diamond). Solid lines represent the U.S. Exclusive Economic Zone (EEZ).

caught animal was apparently able to free itself and was not considered seriously injured (Forney 2004), following established guidelines for assessing serious injury in marine mammals (Angliss and DeMaster 1998). The average 5-yr estimate of annual mortality and serious injury within the Hawaiian Islands EEZ during 1998-2002 is zero sperm whales. One additional sperm whale was observed taken in an experimental set outside the U.S. EEZ, but the severity of its injuries could not be determined (Forney 2004). Since 2001, the Hawaii-based longline fishery has undergone a series of regulatory changes, primarily to protect sea turtles (NMFS 2001). Potential impacts of these regulatory changes on the rate of sperm whale interactions are unknown.

Table 1. Summary of available information on incidental mortality and serious injury of sperm whales (Hawaiian stock) in commercial fisheries, within and outside of the Hawaiian Islands EEZ (Forney 2004). Mean annual takes are based on 1998-2002 data unless otherwise indicated; n/a = not available.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Mortality and Serious Injury outside of U.S. EEZ			Mortality and Serious Injury within Hawaiian Islands EEZ		
				Observed	Estimated (CV in parentheses)	Mean Annual Takes (CV in parentheses)	Observed	Estimated (CV in parentheses)	Mean Annual Takes (CV in parentheses)
Hawaii-based longline fishery	1998 1999 2000 2001 2002	1998-2002 observer data	4.6% 3.5% 11.8% 22.7% 24.9%	0 0 0 0 0	0 (-) 0 (-) 0 (-) 0 (-) 0 (-)	0 (-)	0 0 0 0 0	0 (-) 0 (-) 0 (-) 0 (-) 0 (-)	0 (-)
Experimental longline fishery	2002	observed		1	n/a	0.2 (n/a)			
Minimum total annual takes within U.S. EEZ waters									0 (-)

Historical Mortality

Between 1800 and 1909, about 60,842 sperm whales were estimated taken in the North Pacific (Best 1976). The reported take of North Pacific sperm whales by commercial whalers between 1947 and 1987 totaled 258,000 (C. Allison, pers. comm.). Factory ships operated as far south as 20°N (Ohsumi 1980). Ohsumi (1980) lists an additional 28,198 sperm whales taken mainly in coastal whaling operations from 1910 to 1946. Based on the massive under-reporting of Soviet catches, Brownell et al. (1998) estimate that about 89,000 whales were additionally taken by the Soviet pelagic whaling fleet between 1949 and 1979. The Japanese coastal operations apparently also under-reported catches by an unknown amount (Kasuya 1998). Thus a total of at least 436,000 sperm whales were taken between 1800 and the end of commercial whaling for this species in 1987. Of this grand total, an estimated 33,842 were taken by Soviet and Japanese pelagic whaling operations in the eastern North Pacific from the longitude of Hawaii to the U.S. West coast, between 1961 and 1976 (Allen 1980, IWC statistical Areas II and III), and 965 were reported taken in land-based U.S. West coast whaling operations between 1947 and 1971 (Ohsumi 1980). In addition, 13 sperm whales were taken by shore whaling stations in California between 1919 and 1926 (Clapham et al. 1997). There has been a prohibition on taking sperm whales in the North Pacific since 1988, but large-scale pelagic whaling stopped earlier, in 1980. Some of the whales taken during the whaling era were certainly from a population or populations that occur within Hawaiian waters.

STATUS OF STOCK

The only estimate of the status of North Pacific sperm whales in relation to carrying capacity (Gosho et al. 1984) is based on a CPUE method which is no longer accepted as valid. The status of sperm whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Sperm whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the Hawaiian stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. Insufficient information is available to determine whether the total fishery mortality and serious injury for sperm whales is insignificant and approaching zero mortality and serious injury rate. Furthermore, the effect of interactions with the Hawaii-based longline fishery in U.S. and international waters is not known. The increasing levels of anthropogenic noise in the world's oceans has been suggested to be a habitat concern for whales (Richardson et al. 1995), particularly for deep-diving whales like sperm whales that feed in the oceans' "sound channel".

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