SPERM WHALE (*Physeter macrocephalus*): California/Oregon/Washington 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; 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). Sperm whales are found year-round in California waters (Dohl et al. 1983; Barlow 1995; Forney et al. 1995), but they reach peak abundance from April through mid-June and from the end of August through mid-November (Rice 1974). They were seen in every season except winter (Dec.-Feb.) in Washington and Oregon (Green et al. 1992). Of 176 sperm whales that were marked with Discovery tags off southern California in winter 1962-70, only three were recovered by whalers: one off northern California in June, one off Washington in June, and another far off British Columbia in April (Rice 1974). Recent 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 structure of sperm whale populations in the eastern tropical Pacific is not known, but the only photographic matches of known individuals from this area have been between the Galapagos Islands and coastal waters of South America (Dufault and Whitehead 1995), suggesting that the eastern tropical animals constitute a distinct stock. A recent survey designed specifically to investigate stock structure and

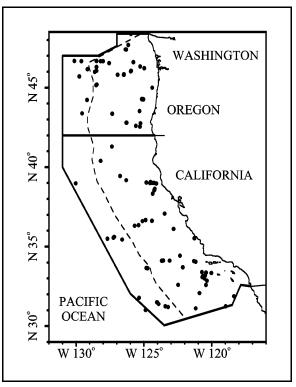


Figure 1. Sperm whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1989-96. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. Greater effort was conducted off California (south of 42°N) and in the inshore half of the U.S. EEZ. See Appendix 2 for data sources and information on timing and location of survey effort.

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). Recent analyses of genetic relationships of animals in the eastern Pacific found that mtDNA and microsatellite DNA of animals sampled in the California Current is significantly different from animals sampled further offshore and that genetic differences appeared larger in an east-west direction than in a north-south direction (Mesnick et al. 1999).

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) California, Oregon and Washington waters (this report), 2) waters around Hawaii, and 3) Alaska waters.

POPULATION SIZE

Barlow and Taylor (2001) estimate 1,407 (CV=0.39) sperm whales along the coasts of California, Oregon, and Washington during summer/fall based on ship line transect surveys in 1993 and 1996. This most recent estimate

has been corrected for the systematic underestimation of sperm whale group size when groups are observed for only a short period of time. Forney et al. (1995) estimate 892 (CV=0.99) sperm whales off California during winter/spring based on aerial line-transect surveys in 1991-92, but this estimate does not correct for diving whales that were missed and is now more than 8 years out of date. Green et al. (1992) report that sperm whales were the third most abundant large whale (after gray and humpback whales) in aerial surveys off Oregon and Washington, but they did not estimate population size for that area. 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. Recently, a combined visual and acoustic line-transect survey conducted in the eastern temperate North Pacific in spring 1997 resulted in estimates of 24,000 (CV=0.46) sperm whales based on visual sightings, and 39,200 (CV=0.60) based acoustic detections and visual group size estimates (Barlow and Taylor 1998). However, it is not known whether any or all of these animals routinely enter the U.S. EEZ. 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), but this area does not include areas where sperm whales are taken by drift gillnet fisheries in the U.S. EEZ and there is no evidence of sperm whale movements from the eastern tropical Pacific to the U.S. EEZ. Barlow and Taylor (2001) also estimate 1,640 (CV=0.33) sperm whales off the west coast of Baja California, but again there is no evidence for interchange between these animals and those off California, Oregon and Washington.

Clearly, large populations of sperm whales exist in waters that are within several thousand miles west and south of the California, Oregon, and Washington region that is covered by this report; however, there is no evidence of sperm whale movements into this region from either the west or south and genetic data suggest that mixing to the west is extremely unlikely. There **is** limited evidence of sperm whale movement from California to northern areas off British Columbia, but there are no abundance estimates for this area. The most precise estimate of sperm whale abundance for this stock is therefore from the ship survey estimate of Barlow and Taylor (2001).

Minimum Population Estimate

The minimum population estimate for sperm whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from the summer/fall ship surveys off California, Oregon and Washington (Barlow and Taylor, 2001) or approximately 1,026. More sophisticated methods of estimating minimum population size would be available if a correction factor (and associated variance) were available to correct the aerial survey estimates for missed animals.

Current Population Trend

Sperm whale abundance appears to have been rather variable off California between 1979/80 and 1996 (Barlow 1994; Barlow 1997) but does not show any obvious trends. Although the population in the eastern North Pacific is expected to have grown since large-scale pelagic whaling stopped in 1980, the possible effects of large unreported catches are unknown (Yablokov 1994) and the ongoing incidental ship strikes and gillnet mortality make this uncertain.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no published estimates of the growth rate for any sperm whale population (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the California portion of this stock is calculated as the minimum population size (1,026) $\underline{\text{times}}$ one half the default maximum net growth rate for cetaceans (½ of 4%) $\underline{\text{times}}$ a recovery factor of 0.1 (the default value for an endangered species), resulting in a PBR of 2.1.

HUMAN-CAUSED MORTALITY Historic Whaling

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.). 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.

Fishery Information

The offshore drift gillnet fishery is the only fishery that is likely to take sperm whales from this stock. Detailed information on this fishery is provided in Appendix 1. A 1995-99 summary of known fishery mortality and injury for this stock of sperm whales is given in Table 1. After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 1999). However, two sperm whales have been observed taken in nets with pingers (1996 and 1998). Because sperm whale entanglement is rare and because those nets which took sperm whales did not use the full mandated complement of pingers, it is difficult to evaluate whether pingers have any effect on sperm whale entanglement in drift gillnets. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes for this fishery (Table 1) are based only on 1997-99 data. is results in an average estimate of 1.7 (CV = 0.89) sperm whale mortalities per year.

Table 1. Summary of available information on the incidental mortality and injury of sperm whales (CA/OR/WA stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999). Injury includes any entanglement that does not result in immediate death and may include serious injury resulting in death. The injured whale observed in 1996 was not expected to survive . n/a indicates that data are not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality (and injury in parentheses)	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1995 1996 1997 1998 1999	observer data	15.6% 12.4% 23.0% 20.0% 20.0%	0 0 (1) 0 1 0	Mortality 0,0,0,5,0 (0.89) Injury 0,1,0,0,0	Mortality 1.7 (0.89) ¹ Injury 0.0 (n/a)
Total annual takes						1.7 (0.89)

Only 1997-99 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California and may take animals from the same population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2,700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson,1998), but species-specific information is not available for the Mexican fisheries. There are currently efforts underway to convert the Mexican swordfish driftnet fishery to a longline fishery (D. Holts, pers. comm.).

Ship Strikes

No sperm whale mortalities have been attributed to ship strikes during the period 1994-98 (J. Cordaro, Southwest Region, NMFS, pers. comm.).

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. Sperm whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the California to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The annual rate of kill and serious injury (1.7 per year) is less than the calculated PBR for this stock (2.1). Total fishery takes may not be approaching zero mortality and serious injury rate. The increasing levels of anthropogenic noise in the world's oceans has been suggested to be a habitat concern for whales, particularly for deep-diving whales like sperm whales that feed in the oceans "sound channel".

REFERENCES

- Allison, C. International Whaling Commission. The Red House, 135 Station Road, Impington, Cambridge, UK CB4 9NP
- Allen, K. R. 1980. Size distribution of male sperm whales in the pelagic catches. Rep. Int. Whal. Commn. Special Issue 2:51-56.
- Barlow, J. 1994. Abundance of large whales in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991. Rept. Int. Whal. Commn. 44:399-406.
- Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fish. Bull. 93:1-14.
- Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Administrative Report LJ-97-11, Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25p.
- Barlow, J., R. W. Baird, J. E. Heyning, K. Wynne, A. M. Manville, II, L. F. Lowry, D. Hanan, J. Sease, and V. N. Burkanov. 1994. A review of cetacean and pinniped mortality in coastal fisheries along the west coast of the U.S. and Canada and the east coast of the Russian Federation. Rep. Int. Whal. Commn, Special Issue 15:405-425.
- Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Report SC/51/SM2 to the Scientific Committee of the International Whaling Commission, May 1999. 20pp.
- Barlow, J., K. A. Forney, P. S. Hill, R. L. Brownell, Jr., J. V. Carretta, D. P. DeMaster, F. Julian, M. S. Lowry, T. Ragen, and R. R. Reeves. 1997. U.S. Pacific Marine Mammal Stock Assessments: 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-248. 223p.
- Barlow, J. and B. L. Taylor. 1998. Preliminary abundance of sperm whales in the northeastern temperate Pacific estimated from a combined visual and acoustic survey. Paper SC/50/CAWS20 presented to the International Whaling Commission, June 1998 (unpublished).
- Barlow, J. and B. L. Taylor. 2001. Estimates of large whale abundance off California, Oregon, Washington, and Baja California based on 1993 and 1996 ship surveys. Administrative Report LJ-01-03 available from Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 12p.
- Best, P. B. 1976. A review of world sperm whale stocks. Paper ACMRR/MM/SC/8 Rev. 1, FAO Scientific Consultation of Marine Mammals, Bergen, Norway.
- Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.
- Brownell, R. L., Jr., A. V. Yablokov and V. A. Zemmsky. 1998. USSR pelagic catches of North Pacific sperm whales, 1949-1979: Conservation implications. Paper SC/50/CAWS27 presented to the International Whaling Commission, June 1998 (unpublished).
- Cameron, G. A. and K. A. Forney. 1999. Preliminary estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, May 1999 (unpublished). 14 pp.
- Clapham, P. J., S. Leatherwood, I. Szczepaniak, and R. L. Brownell, Jr. 1997. Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919-1926. Marine Mammal Science

- 13(3):368-394.
- Cordaro, J. Southwest Region, NMFS, 501 West Ocean Blvd, Long Beach, CA 90802-4213.
- Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-83: Status, abundance, and distribution. Final Report to the Minerals Management Service, Contract No. 14-12-0001-29090. 284p.
- Donovan, G. P. 1991. A review of IWC stock boundaries. Rept. Int. Whal. Commn., Special Issue 13:39-68.
- Dufault, S. and H. Whitehead. 1995. The geographic stock structure of female and immature sperm whales in the South Pacific. Rep. Int. Whal. Commn. 45:401-405.
- Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fish. Bull. 93:15-26.
- Forney, K.A., J. Barlow, M.M. Muto, M. Lowry, J. Baker, G. Cameron, J. Mobley, C. Stinchcomb, and J.V. Carretta. 2000. U.S. Pacific Marine Mammal Stock Assessments: 2000. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-300. 276p.
- Gosho, M. E., D. W. Rice, and J. M. Breiwick. 1984. The sperm whale. Mar. Fish. Rev. 46(4):54-64.
- Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Ch. 1 In: J. J. Brueggeman (ed.). Oregon and Washington Marine Mammal and Seabird Surveys. Minerals Management Service Contract Report 14-12-0001-30426.
- Hanan, D. A. 1986. California Department of Fish and Game coastal marine mammal study, annual report for the period July 1, 1983 - June 30, 1984. Admin. Rept. LJ-86-16 available from Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA. 55pp.
- Hanan, D. A., D. B. Holts, and A. L. Coan, Jr. 1993. The California drift gill net fishery for sharks and swordfish, 1981-82 through 1990-91. Calif. Dept. Fish and Game Fish. Bull. No. 175. 95pp.
- Heyning, J. E., and T. D. Lewis. 1990. Fisheries interactions involving baleen whales off southern California. Rep. int. Whal. Commn. 40:427-431.
- Holts, D. and O. Sosa-Nishizaki. 1998. Swordfish, *Xiphias gladius*, fisheries of the eastern North Pacific Ocean. *In*:
 I. Barrett, O. Sosa-Nishizaki and N. Bartoo (eds.). Biology and fisheries of swordfish, *Xiphias gladius*. Papers from the International Symposium on Pacific Swordfish, Ensenada Mexico, 11-14 December 1994. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 142, 276 pp.
- Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, September 1997 (unpublished). 13 pp.
- Julian, F. and M. Beeson. 1998. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fishery Bulletin 96:271-284.
- Kasuya, T. 1998. Evidence of statistical manipulations in Japanese coastal sperm whale fishery. Paper SC/50/CAWS10 presented to the International Whaling Commission, June 1998 (unpublished).
- Leatherwood, S., K. Goodrich, A. L. Kinter, and R. M. Truppo. 1982. Respiration patterns and 'sightability' of whales. Rep. Int. Whal. Commn. 32:601-613.
- Mesnick, S. L., B. L. Taylor, B. Nachenberg, A. Rosenberg, S. Peterson, J. Hyde, and A. E. Dizon. 1999. Genetic relatedness within groups and the definition of sperm whale stock boundaries from the coastal waters off California, Oregon and Washington. Admin. Rep. LJ-99-12. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 10 pp.
- Miyashita, T., H. Kato, and T. Kasuya (Eds.). 1995. Worldwide map of cetacean distribution based on Japanese sighting data. Volume 1. National Research Institute of Far Seas Fisheries, Shizuoka, Japan. 140pp.
- Ohsumi, S. 1980. Catches of sperm whales by modern whaling in the North Pacific. Rep. Int. Whal. Commn. Special Issue 2: 11-18.
- Rice, D. W. 1988. Sperm whale <u>Physeter macrocephalus</u>, Linnaeus 1758. pp. 177-233 <u>In</u>: S. H. Ridgway and R. J. Harrison (eds.). <u>Handbook of Marine Mammals</u>, <u>Vol. 4</u>. Academic Press, London.
- Sosa-Nishizaki, O., R. De la Rosa Pacheco, R. Castro Longoria, M. Grijalva Chon, and J. De la Rosa Velez. 1993. Estudio biologico pesquero del pez (*Xiphias gladius*) y otras especies de picudos (marlins y pez vela). Rep. Int. CICESE, CTECT9306.
- Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rept. Int. Whal. Commn. 43:477-493.