Revised 1/25/2013

SPERM WHALE (*Physeter macrocephalus*): North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The sperm whale is one of the most widely distributed of any marine mammal species, perhaps only exceeded by the killer whale (Rice 1989). In the North Pacific, sperm whales were depleted by extensive commercial whaling over a period of more than a hundred years, and the species was (numerically) the primary target of illegal Soviet whaling in the second half of the 20th century (Ivashchenko et al. 2013).

Sperm whales feed primarily on medium-sized to large-sized squids but also take substantial quantities of large demersal and mesopelagic sharks, skates, and fishes (Rice 1989). In the North Pacific, sperm whales are distributed widely (Fig. 31), with the northernmost boundary extending from Cape Navarin (62°N) to the Pribilof Islands (Omura 1955). Although females and young sperm whales were thought to remain in tropical and temperate waters year-round, Mizroch and Rice (2006) showed that there were extensive catches of female sperm whales above 50°N and Mizroch and Rice (2012) show female movements into the Gulf of Alaska and western Aleutians and catch concentrations in the western Aleutians. Males are found in the summer to feed in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Kasuya and Miyashita 1988, Mizroch and Rice 2012). Sightings surveys conducted by the NMFS National Marine Mammal Laboratory in the summer months between 2001 and 2010 have found sperm whales to be the most frequently sighted large cetacean in the coastal waters around the central and western Aleutian Islands (NMML unpublished data). Acoustic surveys detected the presence of sperm whales year-round in the Gulf of Alaska although they appear to be more common in summer than in winter (Mellinger et al. 2004). These seasonal detections are consistent with the hypothesis that sperm whales migrate to higher latitudes in summer and migrate to lower latitudes in winter (Whitehead and Arnbom 1987).

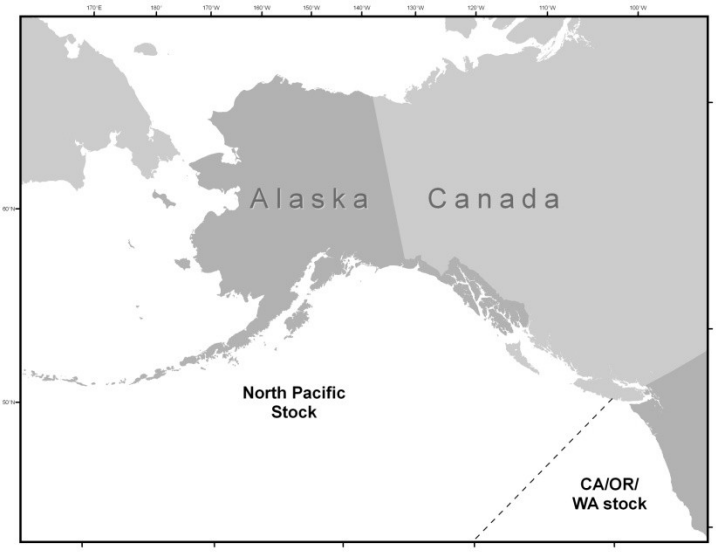

Figure 31. Approximate distribution of sperm whales in the North Pacific includes deep waters south of 62°N to the equator.

Mizroch and Rice (2012) examined 261 Discovery mark recoveries from the days of commercial whaling (recovery data from Omura and Ohsumi 1964, Ivashin and Rovnin 1967, Ohsumi and Masaki 1975, Wada 1980, Kasuya and Miyashita 1988) and found extensive movements from U.S. and Canadian coastal waters into the Gulf of Alaska and Bering Sea. Rice (AFSC-NMML, retired, pers. comm.) marked 176 sperm whales during U.S. cruises from 1962-1970, mostly between 32° and 36° N off the California coast. Seven of those marked whales in locations ranging from offshore California, Oregon, British Columbia waters to the western Gulf of Alaska. A male whale marked by Canadian researchers moved from near Vancouver Island, British Columbia to the Aleutian Islands near Adak. A whale marked by Soviet researchers moved from coastal Michoacán, mainland Mexico to a location about 1,300 km offshore of Washington state. Similar extensive movements have also been demonstrated by recent satellite tagging studies (Jan Straley, Univ. of Alaska, Southeast, pers. comm., May 2012). Three adult males satellite-tagged off southeastern Alaska moved far south, one to coastal Baja California, one into the north-central Gulf of California, and the other to a location near the Mexico-Guatemala border (Jan Straley, Univ. of Alaska, Southeast, pers. comm., May 2012). Marking data show extensive movements throughout the North Pacific and along the U.S. west coast into the Gulf of Alaska and Bering Sea/Aleutian Islands region (BSAI). Mizroch and Rice (2012) also analyzed whaling data and found that males and females concentrated seasonally along oceanic frontal zones, e.g., in the subtropical frontal zone (ca. 28-34°N lat) and the subarctic frontal zones (ca. 40-43°N lat). Males also concentrated seasonally near the Aleutian Islands and along the Bering Sea shelf edge.

Their analyses of marking and whaling data indicate that there are no apparent divisions between separate demes or stocks within the North Pacific.

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: no apparent discontinuities based on whale marking data; 2) Population response data: unknown; 3) Phenotypic data: unknown; and 4) Genotypic data: genetics studies indicate the possibility of a "somewhat" discrete US coastal stock (Mesnick et al. 2011). For management purposes, the International Whaling Commission (IWC) recognizes two management units of sperm whales in the North Pacific (eastern and western). However, the IWC has not reviewed its sperm whale stock boundaries in recent years (Donovan 1991). For management purposes, three stocks of sperm whales are currently recognized in U.S. waters: 1) Alaska (North Pacific stock), 2) California/Washington/Oregon, and 3) Hawaii. New information from Mizroch and Rice (2012) suggests that this structure should be reviewed and updated to reflect current data. The California/Oregon/Washington and Hawaii sperm whale stocks are reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

Current and historic estimates for the abundance of sperm whales in the North Pacific are considered unreliable. Therefore, caution should be exercised in interpreting published estimates of abundance. The abundance of sperm whales in the North Pacific was reported to be 1,260,000 prior to exploitation, which by the late 1970s was estimated to have been reduced to 930,000 whales (Rice 1989). Confidence intervals for these estimates were not provided. These estimates include whales from the California/Oregon/Washington stock, for which a separate abundance estimate is currently available (see Stock Assessment Reports for the Pacific Region).

Although Kato and Miyashita (1998) believe their estimate to be upwardly biased, their preliminary analysis indicates 102,112 (CV = 0.155) sperm whales in the western North Pacific. The number of sperm whales of the North Pacific occurring within Alaska waters is unknown. As the data used in estimating the abundance of sperm whales in the entire North Pacific are over 8 years old at this time and there are no available estimates for numbers of sperm whales in Alaska waters, a reliable estimate of abundance for the North Pacific stock is not available.

Minimum Population Estimate

At this time, it is not possible to produce a reliable estimate of minimum abundance for this stock, as a current estimate of abundance is not available.

Current Population Trend

No current estimate of abundance exists for this stock; therefore, reliable information on trends in abundance for this stock is currently not available (Braham 1992).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is not currently available for the North Pacific stock of sperm whale. Hence, until additional data become available, it is recommended that the cetacean maximum net productivity rate (R_{MAX}) of 4% be employed for this stock at this time (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.1, the value for cetacean stocks which are classified as endangered (Wade and Angliss 1997). However, because a reliable estimate of minimum abundance N_{MIN} is currently not available, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

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

Between 2007 and 2011, there was one observed serious injuries of a sperm whale in the Gulf of Alaska sablefish longline fishery (Table 40). This animal was designated as seriously injured because it became caught in the gear, and was released alive with trailing gear. Thus, the mean annual estimated level of serious injury and mortality of the the North Pacific stock of sperm whale stock for 2007-2011 is 0.28 (Table 40).

Table 40. Summary of incidental mortality and serious injury of sperm whales due to commercial fisheries and calculation of the mean annual mortality rate (Breiwick 2013). Mean annual takes are based on 2007-2011 data. Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
GOA sablefish longline	2007	obs data	17	1	1.4	0.28 (CV = 0.57)
	2008		16	0	0	
	2009		16	0	0	
	2010		15	0	0	
	2011		14	0	0	
Estimated total annual takes						0.28 (CV = 0.57)

Subsistence/Native Harvest Information

Sperm whales have never been reported to be taken by subsistence hunters (Rice 1989).

Other Mortality

Sperm whales were the dominant species killed by the commercial whaling industry as it developed in the North Pacific in the years after the second World War (Mizroch and Rice 2006). Between 1946 and 1967, most of the sperm whales were caught in waters near Japan and in the Bering Sea/Aleutian Islands (BSAI) region. The BSAI catches were dominated by males. After 1967, whalers moved out of the BSAI region and began to catch even larger numbers of sperm whales further south in the North Pacific between 30° and 50° N (Mizroch and Rice 2006, Figs. 7-9). The reported catch of sperm whales taken by commercial whalers operating in the North Pacific between 1912 and 2006 was 261,148 sperm whales, of which, 259,120 were taken between 1946 and 1987 (International Whaling Commission, BIWS catch data, February 2008 version, unpublished). This value underestimates the actual kill in the North Pacific as a result of under-reporting by U.S.S.R. pelagic whaling operations. Berzin (2008) described extreme underreporting and misreporting of Soviet sperm whale catches from the mid-1960s into the early 1970s including enormous (and underreported) whaling pressure on female sperm whales in the latter years of whaling. More recently, Ivashchenko et al. (2013) estimate that more than 159,000 sperm whales were killed by the USSR in the North Pacific between 1948 and 1979. In addition, new information suggests that Japanese land-based whaling operations also under-reported sperm whale catches during the post-World War II era (Kasuya 1999). The last year that the U.S.S.R reported catches of sperm whales was in 1979 and the last year that Japan reported substantial catches was in 1987, but Japanese whalers reported catches of 48 sperm whales between 2000 and 2009 (International Whaling Commission, BIWS catch data, October 2010 version, unpublished).

From 2006-2010, there were 11 sperm whale mortalities reported to Alaska Region Stranding Program (NMFS Alaska Regional Office, unpublished data). Human interaction for these cases could not be determined.

Other Issues

NMFS observers aboard longline vessels targeting both sablefish and halibut have documented sperm whales feeding off longline gear in the Gulf of Alaska (Hill and Mitchell 1998, Hill et al., 1999, Perez 2006, Sigler et al. 2008). Fishery observers recorded several instances during 1995-97 in which sperm whales were deterred by fishermen (i.e., yelling at the whales or throwing seal bombs in the water).

Annual longline surveys have been recording sperm whale predation on catch since 1998 (Hanselman et al. 2008). Sperm whale depredation in the sablefish longline fishery is widespread in the Central and Eastern Gulf of Alaska, but rarely observed in the Bering Sea; the majority of interactions occur in the West Yakutat and East

Yakutat/Southeast areas (Hanselman et al. 2008; Perez 2006). Sigler et al. (2008) analyzed catch data from 1998-2004 and found that catch rates were about 2% less at locations where depredation occurred, but the effect was not significant ($p = 0.34$). Hill et al. (1999) analyzed data collected by fisheries observers in Alaska waters and also found no significant effect on catch. A small, significant effect on catch rates was found in a study using data collected in southeast Alaska, in which longline fishery catches between sets were compared with sperm whales present and sets with sperm whales absent (3% reduction, t-test, 95% CI of (0.4 – 5.5%), $p = 0.02$, Straley et al. 2005). Undamaged catches may also occur when sperm whales are present; in these cases, sperm whales apparently feed off the discard.

STATUS OF STOCK

Sperm whales are listed as "endangered" under the Endangered Species Act of 1973, and therefore designated as "depleted" under the MMPA. As a result, this stock is classified as a strategic stock. However, on the basis of total abundance, current distribution, and regulatory measures that are currently in place, it is unlikely that this stock is in danger of extinction (Braham 1992). Reliable estimates of the minimum population, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population size are currently not available, although the estimated annual rate of human-caused mortality and serious injury seems minimal for this stock. Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown.

HABITAT CONCERNS

There are no known habitat issues that are of particular concern for this stock.

CITATIONS

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. NOAA Tech Memo. NMFS-OPR-13, 48 p.

Andersen, M. S., K. A. Forney, T. V. N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating Serious and Non-Serious Injury of Marine Mammals: Report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-39. 94 p.

Berzin A. A. 2008. The truth about Soviet whaling: A memoir. Mar. Fish. Rev. 70(2):4-59.

Braham, H. 1992. Endangered whales: Status update. Working document presented at A Workshop on the Status of California Cetacean Stocks (SOCCS/14). 35 pp. + tables. (Available upon request - Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98115).

Breiwick, J. M. 2013. North Pacific marine mammal bycatch estimation methodology and results, 2007-2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-260, 40 p.

Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogeographic approach. Conserv. Biol. 6:24-36.

Donovan, G. P. 1991. A review of IWC stock boundaries. Rept. Int. Whal. Comm. (Special Issue 13):39-68.

Hanselman, D. H., C. R. Lunsford, J. T. Fujioka, and C. J. Rodgveller. 2008. Assessment of the sablefish stock in Alaska. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. North Pac. Fish. Mgmt. Counc., Anchorage, AK, Section 3:303-420.

Hill, P. S., and E. Mitchell. 1998. Sperm whale interactions with longline vessels in Alaska waters during 1997. Unpubl. doc. Submitted to Fish. Bull., U.S. (Available upon request – S. Mizroch, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98115).

Hill, P. S., J. L. Laake, and E. Mitchell. 1999. Results of a pilot program to document interactions between sperm whales and longline vessels in Alaska waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-108, 42 pp.

Ivashchenko, Y.V., Clapham, P.J. and Brownell, R.L. Jr. 2013. Soviet catches of whales in the North Pacific: revised totals. Journal of Cetacean Research and Management. 13(1): 59–71.

Ivashin M. V., and A. A. Rovnin. 1967. Some results of the Soviet whale marking in the waters of the North Pacific. Norsk Hvalfangst-tidende 56:123-135.

Kasuya, T. 1999. Examination of the reliability of catch statistics in the Japanese coastal sperm whale fishery. J. Cetacean Res. Manage. 1: 109-122.

Kasuya T., and T. Miyashita. 1988. Distribution of sperm whale stocks in the North Pacific. Sci. Rep. Whales Res. Inst. 39: 31-75.

Kato, H., and T. Miyashita. 1998. Current status of North Pacific sperm whales and its preliminary abundance estimates. Unpubl. report submitted to Int. Whal. Comm. (SC/50/CAWS/52). 6 pp.

Mellinger, D. K., Stafford, K. M., and Fox, C. G. 2004. Seasonal occurrence of sperm whale (*Physeter macrocephalus*) sounds in the Gulf of Alaska, 1999-2001. Mar. Mammal Sci. 20(1):48-62.

Mesnick S. L., B. L. Taylor, F. I. Archer, K. K. Martien, et al. 2011. Sperm whale population structure in the eastern and central North Pacific inferred by the use of single nucleotide polymorphisms, microsatellites and mitochondrial DNA. Mol. Ecol. Res. 11 (Suppl. 1):278-298.

Mizroch S. A., and D. W. Rice. 2006. Have North Pacific killer whales switched prey species in response to depletion of the great whale populations? Mar. Ecol. Prog. Ser. 310:235-246.

Mizroch S. A., and D. W. Rice. 2012. Ocean nomads: distribution and movements of sperm whales in the North Pacific shown by whaling data and Discovery marks. Mar. Mamm. Sci. 29(2):E136-E165. DOI: 10.1111/j.1748-7692.2012.00601.x

NOAA. 2012. Federal Register 77:3233. National Policy for Distinguishing Serious From Non-Serious Injuries of Marine Mammals. http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf.

Ohsumi S., and Y. Masaki. 1975. Japanese whale marking in the North Pacific, 1963-1972. Bull. Far Seas Fish. Res. Lab. 12:171-219.

Omura, H. 1955. Whales in the northern part of the North Pacific. Nor. Hvalfangst-tidende 44(6):323-345.

Omura H., and S. Ohsumi. 1964. A review of Japanese whale marking in the North Pacific to the end of 1962, with some information on marking in the Antarctic. Norsk Hvalfangst-tidende 53:90-112.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167, 194 pp.

Rice, D. W. 1989. Sperm whale, *Physeter macrocephalus*. Pp. 177-233 *In* S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals. Vol. 4. River Dolphins and the Larger Toothed Whales. Academic Press, New York.

Sigler, M. F. Lunsford, C. R., Straley, J. M., and Liddle, J. B. 2008. Sperm whale depredation of sablefish longline gear in the northeast Pacific Ocean. Mar. Mammal Sci. 24(1):16-27.

Straley, J., T. O'Connell, S. Mesnick, L. Behnken, and J. Liddle. 2005. Sperm Whale and Longline Fisheries Interactions in the Gulf of Alaska. North Pacific Research Board R0309 Final Report, 15 p.

Wada S. 1980. On the genetic uniformity of the North Pacific sperm whale. Reports of the Int. Whal. Comm. Special Issue 2:205-211.

Wade, P. R., and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Whitehead, H. and Arnbom, T. 1987. Social organization of sperm whale off the Galapagos Island, February-April 1985. Can. J. Zool. 65(4):913-919.