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U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2002

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PREFACE

Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) are required to publish Stock Assessment Reports for all stocks of marine mammals within U.S. waters, to review new information every year for strategic stocks and every three years for non-strategic stocks, and to update the stock assessment reports when significant new information becomes available. This report presents revised stock assessments for 13 Pacific marine mammal stocks under NMFS jurisdiction. Information on the remaining 44 Pacific region stocks is reprinted without revision and also appears in the 2001 reports (Carretta *et al.* 2001). In the 2002 stock assessments, there are now four stocks of harbor porpoise (*Phocoena phocoena*) occurring in California waters, where previously there had been two. These new stock boundaries reflect recent genetic analyses on the small-scale population structure of harbor porpoise in the eastern North Pacific (Chivers *et al.* 2002). Stock Assessments for Alaskan marine mammals are published by the National Marine Mammal Laboratory (NMML) in a separate report. The stock assessment for Eastern North Pacific transient killer whales now appears in the Alaska region report.

The 13 revised stock assessments in this report include stocks studied by the Southwest Fisheries Science Center (SWFSC, La Jolla, California and Honolulu, Hawaii laboratories) and the National Marine Mammal Laboratory (NMML, Seattle, Washington). Staff of the National Marine Mammal Laboratory prepared the report on the Eastern North Pacific Southern Resident killer whale, Washington Inland Waters harbor seal, Oregon/Washington coast harbor seal, Washington Inland waters harbor porpoise, and Oregon/Washington coast harbor porpoise. Honolulu laboratory staff prepared the report on the Hawaiian monk seal. SWFSC, La Jolla Laboratory staff prepared stock assessments for 4 harbor porpoise stocks (Morro Bay, Monterey Bay, San Francisco-Russian River, and northern California/southern Oregon), northern elephant seal (California breeding stock), eastern North Pacific humpback whale, and Hawaii false killer whale .

New abundance estimates are available for 12 stocks: northern elephant seal, Hawaiian monk seal, Washington Inland waters harbor seal, Oregon/Washington coast harbor seal, eastern North Pacific southern resident killer whale, eastern North Pacific humpback whale, Washington Inland waters and Oregon/Washington coast harbor porpoise, northern California/southern Oregon harbor porpoise, San Francisco-Russian River harbor porpoise, Monterey Bay harbor porpoise, and Morro Bay harbor porpoise. New information on changes in the Hawaiian longline fishery is presented in the Hawaii false killer whale report.

Earlier versions of these stock assessment reports were reviewed by members of the Pacific and Alaska Scientific Review Groups; we thank them for their helpful comments. The authors also wish to thank those who provided unpublished data. Any omissions or errors are the sole responsibility of the authors.

This is a working document and individual stock assessment reports will be updated as new information becomes available and as changes to marine mammal stocks and fisheries occur. The authors solicit any new information or comments which would improve future stock assessment reports.

References:

Carretta, J.V., J. Barlow, K.A. Forney, M.M. Muto, and J. Baker. 2001. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-317. 280p.

Chivers, S.J., A.E. Dizon, P.J. Gearin, and K.M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises, (*Phocoena phocoena*), indicated by molecular genetic analyses. Journal of Cetacean Research and Management 4(2):111-122.

Cover photo: Transient killer whale attacking a Dall's porpoise. October 12, 1996, 10 nmi west of Coos Bay, Oregon. Photographed by Charles Stinchcomb.

Revised 12/15/2000

CALIFORNIA SEA LION (*Zalophus californianus californianus*): U.S. Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The California sea lion *Zalophus californianus* includes three subspecies: *Z. c. wollebaeki* (on the Galapagos Islands), *Z. c. japonicus* (in Japan, but now thought to be extinct), and *Z. c. californianus* (found from southern Mexico to southwestern Canada; herein referred to as the California sea lion). The breeding areas of the California sea lion are on islands located in southern California, western Baja California, and the Gulf of California (Figure 1). These three geographic regions are used to separate this subspecies into three stocks: (1) the United States stock begins at the U.S./Mexico border and extends northward into Canada; (2) the Western Baja California stock extends from the U.S./Mexico border to the southern tip of the Baja California Peninsula; and (3) the Gulf of California stock which includes the Gulf of California from the southern tip of the Baja California peninsula and across to the mainland and extends to southern Mexico (Lowry et al. 1992). Some movement has been documented between these geographic stocks, but rookeries in the United States are widely separated from the major rookeries of western Baja California, Mexico. Males from western Baja California rookeries may spend most of the year in the United States. Genetic differences have been found between the U.S. stock and the Gulf of California stock (Maldonado et al. 1995). There are no international agreements for joint management of California sea lions between the U.S., Mexico, and Canada.

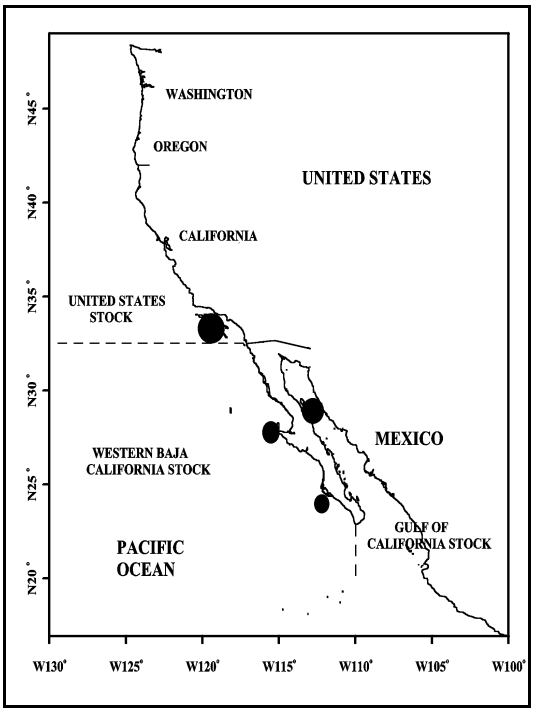

Figure 1. Geographic range of California sea lions showing stock boundaries and locations of major rookeries.

POPULATION SIZE

The entire population cannot be counted because all age and sex classes are never ashore at the same time. In lieu of counting all sea lions, pups are counted during the breeding season (because this is the only age class that is ashore in its entirety), and the number of births is estimated from the pup count. The size of the population is then estimated from the number of births and the proportion of pups in the population.

Censuses are conducted in July after all pups have been born. To estimate the number of pups born, the pup count in 1999 (42,388) was adjusted for an estimated 15% pre-census mortality (Boveng 1988; Lowry et al. 1992), giving an estimated 48,746 live births in the population. The fraction of newborn pups in the population (22.8% to 23.9%) was estimated from a life table derived for the northern fur seal (*Callorhinus ursinus*) (Boveng 1988, Lowry et al. 1992) which was modified to account for the growth rate of this California sea lion population (5.0% to 6.2% yr^{-1}, respectively, see below). Multiplying the number of pups born by the inverse of these fractions (4.39 to 4.19) results in population estimates ranging from 214,000 to 204,000 (respectively).

Minimum Population Estimate

The minimum population size was determined from counts of all age and sex classes that were ashore at all the major rookeries and haulout sites during the 1999 breeding season. The minimum population size of the U.S. stock is 109,854 (NMFS unpubl. data). It includes all California sea lions counted during the July 1999 census at the four rookeries in southern California and at the haulout sites located between Point Conception and the Oregon/California border. *An additional unknown number of California sea lions are at sea or hauled out at locations that were not censused.*

Current Population Trend

Records of pup counts from 1975 to 1999 (Figure 2) were compiled from the literature, NMFS reports, unpublished NMFS data, and Lowry 1999 (the literature up to 1992 is listed in Lowry et al. 1992). Pup counts from 1975 through 1999 were examined for four rookeries in southern California and for haulouts in central and northern California. Log-linear interpolation between adjacent counts was used to estimate counts for rookeries when they were not censused in a given year: (1) 1980 at Santa Barbara Is.; (2) 1978-1980 at San Clemente Is.; (3) 1978, 1979, 1988, and 1989 at San Nicolas Is. The mean was used when more than one count was available for a given rookery. Also, an index was used for San Miguel Island because some years lacked data for certain areas. Three major declines in the number of pups counted occurred during El Niño events in 1983, 1992-93, and 1998 (Figure 2). A regression of the natural logarithm of the pup counts against year indicates that the counts of pups increased at an annual rate of 5.0% between 1975 and 1999. The counts of pups between the 1976, 1983, and 1992 El Niño events increased at 8.8% annually (from 1976 to 1982) and at 10.2% annually (from 1983 to 1991). Since 1983, the counts of pups has increased at 6.2% annually.

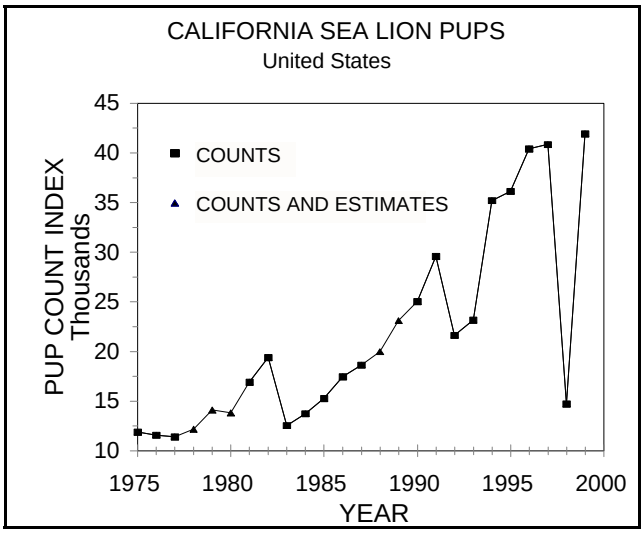

Figure 2. U.S pup count index for California sea lions (1975-99).

The 1975-99 time series of pup counts shows the effect of three El Niño events on the sea lion population. Pup production decreased by 35 percent in 1983, 27 percent in1992, and 64 percent in 1998. After the 1992-93 and 1997-98 El Niños, pup production rebounded by 52 percent and 185 percent, respectively, but there was no rebound after the 1983-84 El Niño (Figure 2). Unlike the 1992-93 and 1997-98 El Niños, the 1983-84 El Niño affected adult female survivorship (DeLong et al 1991) which prevented the rebound in pup production after the event was over because there were fewer adult females available in the population to produce a pup (it took five years for pup production to return to the 1982 level). Other characteristics of El Niños are higher pup and juvenile mortality rates (DeLong et al 1991, NMFS unpubl. data) which affect future recruitment into the adult population for the affected cohorts. The long term effects of the 1992-93 event, which resulted in fewer females being recruited into the adult population, is manifested in lower net productivity rates for 1997 and 1999 (relative to 1997; Figure 2) because fewer females reached reproductive age (females reach reproductive age at 3 to 5 years). Therefore, the effects of the 1992-93 and 1997-98 El Niños will result in lower net productivity rates for several years due to a drop in adult female recruitment. The drop in net production shows the long-term effect of El Niños and does not signal that the population has reached carrying capacity. The severity, timing, length, and frequency of future El Niños will govern the growth rate of the sea lion population in the future.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The rate of net production is greater than the observed growth rate because human related mortalities take a fraction of the net production. Net productivity was, therefore, calculated for 1980-1999 as the realized rate of population growth (increase in pup counts from year *I* to year *I*+1, divided by pup count in year *I*) plus human related mortalities (fishery and non-fishery mortalities in year *I* divided by population size in year *I*). For California sea lions, the total mortalities estimated from NMFS, California Dept. of Fish and Game, Columbia River Area observer programs, and reports from stranding programs and from salmon net pen fisheries were 1,967, 1,967, 1,967, 4,344, 2,476, 2,364, 4,417, 2,847, 3,753, 2,315, 2,753, 1,901, 3,520, 2,039, 946, 827, 1,107, 1,502, 1,435, 1,348 for 1980 to 1998, respectively (Miller et al. 1983; Hanan et al. 1988; Hanan and Diamond 1989; Brown and Jeffries 1993; Barlow et al. 1994, Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999, NMFS unpubl. data). Fishery mortality for 1999 (1,261) was estimated as the mean of 1996-1998.

Between 1980 and 1999 the net productivity rate averaged 16.1% (Figure 3). A regression (thin line) shows a slight increase in net production rates, but the regression is strongly influenced by the El Niño years (1983, 1992, and 1998) and the high net production rate during El Niño recovery years (1994 and 1999). When El Niño years (1983, 1992, and 1998) and El Niño recovery years (1994 and 1999) are removed, the regression line shows a slight decrease (thick line) and net production averages 13.2%. Maximum net productivity rates cannot be estimated from available data.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (109,854) times one half the default maximum net growth rate for pinnipeds (½ of 12%) times a recovery factor of 1.0 (for a stock of unknown status that is growing, Wade and Angliss 1997); resulting in a PBR of 6,591 sea lions per year.

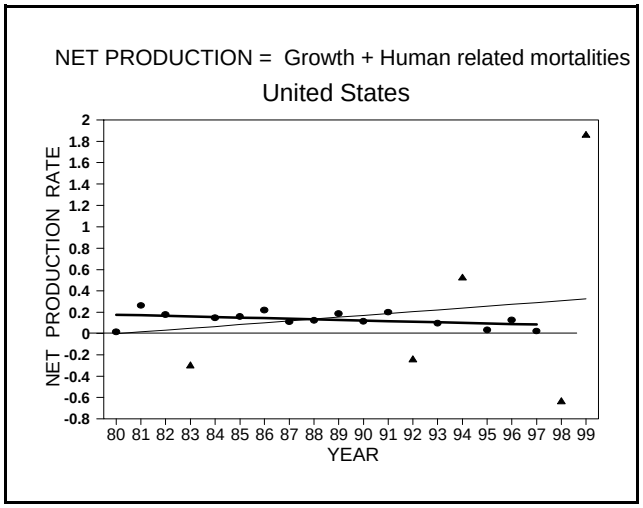

Figure 3. Net productivity rates and regression lines estimated from pup counts with corrections for incidental human related mortalities. Thick line excludes El Niño years and El Niño recovery years (i.e., triangles); thin line includes all years.

ANNUAL HUMAN-CAUSED MORTALITY

Fisheries Information

California sea lions are killed incidentally in set and drift gillnet fisheries (Hanan et al. 1993; Barlow et al. 1994; Julian 1997; Julian and Beeson, 1998, Cameron and Forney 1999; Table 1). Detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California the set and drift gillnet fisheries are included in Table 1 for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). A controlled experiment during 1996-97 demonstrated that the use of acoustic warning devices (pingers) reduced sea lion entanglement rates considerably within the drift gillnet fishery (Barlow and Cameron 1999). However, entanglement rates increased again during the 1997 El Niño and continued during 1998. The reasons for the increase in entanglement rates are unknown. However, it has been suggested that sea lions may have foraged further offshore in response to limited food supplies near rookeries, which would provide opportunity for increased interactions with the drift gillnet fishery (Barlow and Cameron 1999). Because of interannual variability in entanglement rates, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 158 (CV = 0.23) California sea lions taken annually.

Logbook and observer data, and fisher reports, indicate that mortality of California sea lions occurs, or has occurred in the past, also in the following fisheries: (1) California, Oregon, and Washington salmon troll fisheries; (2) Oregon and Washington non-salmon troll fisheries; (3) California herring purse seine fishery; (4) California anchovy, mackerel, and tuna purse seine fishery; (5) California squid purse seine fishery, (6) Washington, Oregon, California and British Columbia, Canada salmon net pen fishery, (7) Washington, Oregon, California groundfish trawl fishery, and (8) Washington, Oregon and California commercial passenger fishing vessel fishery (NMFS 1995, M. Perez pers. comm, and P. Olesiuk pers. comm.). The OR Columbia River gillnet fishery has been reduced to such levels that California sea lion mortality, if any, is negligible (J. Scordino, per. comm.). The California Marine Mammal Stranding Network database maintained by the National Marine Fisheries Service, Southwest Region contains records of human-related fishery mortalities of stranded California sea lions. These records show that at least 17 additional mortalities and 17 injuries occurred in 1998 as a result of fishing net entanglement and 24 additional mortalities and 31 injuries from hook and line fisheries.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico

and may take animals from the U.S. stock. 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 has 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.).

Table 1. Summary of available information on the mortality and serious injury of California sea lions in commercial fisheries that might take this species (Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999, M. Perez per. comm, Appendix 1). Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA driftnet fishery for sharks and swordfish	1994 1995 1996 1997 1998	observer	17.9% 15.6% 12.4% 23.0% 20.0%	5 4 4 36 23	28 (0.40) 26 (0.45) 36 (0.55) 201(0.34) 114 (0.23)	158 (0.23)[1]
CA set gillnet fishery for halibut and angel shark	1994 1995 1996 1997 1998	observer estimate extrapolated estimate	7.7% 0% 0% 0% 0%	109 - - - -	905 (0.15) 724 (0.08) [1] 999 (0.06) [1] 1,206 (0.06) [1] 1,228 (0.07) [1]	1,012 (0.04)[2]
WA, OR, CA domestic groundfish trawl fishery (At-sea processing Pacific whiting fishery only)	1994 1995 1996 1997 1998	observer	53.8% 56.2% 65.2% 65.7% 77.3%	1 0 0 0 1	2(0.68) 0 0 0 1(0.48)	1(0.48)
WA, OR salmon net pen fishery	1996 1997 1998	logbook		4 9 9	4 9 9	7(0.39)
Canada: BC salmon pen fishery	1994 1995 1996	reports			13 23 54	30(0.71)
Minimum total annual takes						1,208 (0.05)

[1] Only 1997-98 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).

[2] The CA set gillnets were not observed after 1994; mortality was extrapolated from effort estimates and previous entanglement rates. Changes in the distribution of effort in this fishery add considerable uncertainty to these estimates.

Other Mortality

California sea lions that were injured by entanglement in gillnet and other man-made debris have been observed at rookeries and haulouts (Stewart and Yochem 1987, Oliver 1991). The proportion of those entangled ranged from 0.08% to 0.35% of those present on land, with the majority (52%) entangled with monofilament gillnet material. A

marine mammal rehabilitation center found that 87% of 87 rescued California sea lions were entangled in 4 to 4.5 inch square-mesh monofilament gillnet (Howorth 1995). Of California sea lions entangled in gillnets, 0.8% in set gillnets and 5.4% in drift gillnets were observed to be released alive from the net by fishers during 1991-95 (Julian and Beeson 1998). Clearly, some are escaping from gillnets after being caught by them; however, the rate of escape from gillnets, as well as the mortality rate of these injured animals, is unknown.

Live strandings and dead beach-cast California sea lions have also been observed with gunshot wounds in California (Lowry and Folk 1987, Deiter 1991, Barocchi et al. 1993). A summary of records for 1998 from the California Marine Mammal Stranding Network (CMMSN) and the Oregon and Washington stranding databases shows the following non-fishery related mortality: boat collision (3 mortalities), entrainment in power plants (30 mortalities), and shootings (70 mortalities and 8 injuries). Stranding records are a gross under-estimate of injury and mortality. However, CMMSN stranding records indicate a higher mortality rate as a result of shootings and hook and line entanglements during the1997-98 El Niño period (115 shootings, 26 hook and line entanglements) than during the 1995-96 non-El Niño period (61 shootings, 5 hook and line entanglements). There are currently no estimates of the total number of California sea lions being killed or injured by guns, boat collisions, entrainment in power plants, marine debris, or gaffs, but the minimum number in 1998 was 144.

Several Northwest Indian tribes have developed, or are in the process of developing, regulations for ceremonial and subsistence harvests of California sea lions and for the incidental take of marine mammals during tribal fisheries. The tribes have agreed to cooperate with NMFS in gathering and submitting data on takes of marine mammals.

Sea lion mortalities in 1998 along the central California coast have recently been linked to the algal-produced neurotoxin domoic acid (Scholin et al. 2000). Future mortalities may be expected to occur, owing to the periodic nature of such harmful algal blooms.

STATUS OF STOCK

Lowry et al. (1992) concluded that there was no evidence of a density dependent signal in counts of California sea lions between 1983 and 1990, and that it was not possible to determine the status of this stock relative to OSP. They are not listed as "endangered" or "threatened" under the Endangered Species Act or as "depleted" under the MMPA. They are not considered a "strategic" stock under the MMPA because total human-caused mortality (1208 fishery-related mortalities plus 144 from other sources) is less than the PBR (6,591). The total fishery mortality and serious injury rate for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. The population has been growing recently at 6.2% per year, and the fishery mortality is increasing.

REFERENCES

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 USA and Canada and the east coast of the Russian Federation. Rept. Int. Whaling Comm., Special Issue 15:405-425.

Barlow, Jay, and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to International Whaling Commission, May 1998 (unpublished). 20 pp.

Barocchi, M., L. E. Morgan, and K. D. Hanni. 1993. Frequency of fishery interactions among live stranded pinnipeds in central and northern California. (abstract). Tenth Biennial Conference on the Biology of Marine Mammals, Galveston TX, November 11-15, 1993.

Boveng, P. 1988. Status of the California sea lion population on the U.S. west coast. Admin. Rep. LJ-88-07. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Brown, R. F. and S. J. Jeffries. 1993. Preliminary report on estimated marine mammal mortality in Columbia River fall and winter salmon gillnet fisheries, 1991-1992. Columbia River Area Marine Mammal Observer Program, 53 Portway St., Astoria, OR. 13 pp.

Cameron, G. A. and K. A. Forney. 1999. Preliminary estimate of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/04 presented to International Whaling Commission, May 1999 (unpublished). 14 pp.

Deiter, R. L. 1991. Recovery and necropsy of marine mammal carcasses in and near the Point Reyes national Seashore, May 1982-March 1987. In J. E. Reynolds III and D. K. Odell (editors), Marine mammal strandings in the United States, Proceedings of the second marine mammal stranding workshop, Miami, Florida, December 3-5-1987. p. 123-141. NOAA Technical Rept. NMFS 98.

DeLong, R. L., G. A. Antonelis, C. W. Oliver, B. S. Stewart, M. S. Lowry, and P. K. Yochem. 1991. Effects of the 1982-1983 El Niño on several population parameters and diet of California sea lions on the California Channel Islands. In F. Trillmich and K. A. Ono (editors), Pinnipeds and El Niño: Responses to environmental stress. p. 166-172. Springer-Verlag, Berlin Heidelberg New York.

Hanan, D. A., and S. L. Diamond. 1989. Estimates of sea lion, harbor seal, and harbor porpoise mortalities in California set net fisheries for the 1986-87 fishing year. Final Report. Cooperative agreement No. NA-86-ABH-00018. NOAA/NMFS SWR, January 1989. 10 pp.

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. 95 p.

Hanan, D. A., J. P. Scholl, and S. L. Diamond. 1988. Estimates of sea lion and harbor seal mortalities in California set net fisheries for 1983, 1984, and 1985. Final Report. Cooperative agreement No. NA-86-ABH-00018. NOAA/NMFS SWR October 1988. 10 pp.

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.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

Howorth, P. C. 1995. Entanglement of marine mammals in synthetic debris. NMFS/SWFSC contract report 40JGNF100597.

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 for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

Lowry, M. S. 1999. Counts of California sea lion (*Zalophus californianus*) pups from aerial color photographs and from the ground: a comparison of two methods. Marine Mammal Science 15:143-158.

Lowry, M. S. and R. L. Folk. 1987. Feeding habits of California sea lions from stranded carcasses collected at San Diego County and Santa Catalina Island, California. Admin. Rep. LJ-87-15. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 33 pp.

Lowry, M. S., P. Boveng, R. J. DeLong, C. W. Oliver, B. S. Stewart, H. DeAnda, and J. Barlow. 1992. Status of the California sea lion (*Zalophus californianus californianus*) population in 1992. Admin. Rep. LJ-92-32. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA 92038. 34 pp.

Maldonado, J. E., F. O. Davila, B. S. Stewart, E. Greffen, and R. K Wayne. 1995. Intraspecific genetic differentiation in California sea lions (*Zalophus californianus*) from southern California and the Gulf of California. Mar. Mamm. Sci. 11(1):46-58.

Miller, D. J., M. J. Herder, and J. P. Scholl. 1983. California marine mammal-fishery interaction study, 1979-1981. Administrative Rept. LJ-83-13C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 233 p.

NMFS. 1995. Environmental assessment of proposed regulations to govern interactions between marine mammals and commercial fishing operations, under Section 118 of the Marine Mammal Protection Act. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, June 1995. 139 pp. + 4 Appendices.

Oliver, C. W. 1991. 1988-1991 field studies on pinnipeds at San Clemente Island. Admin. Rep. LJ-91-27. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 33 pp.

Scholin, C. A., Gulland, F., Doucette, G. J., Benson, S., Busman, M., Chavez, F. P., Cordaro, J., DeLong, R., De Vogelaere, A., Harvey, J., Haulena, M., Lefebvre, K., Lipscomb, T., Loscutoff, S., Lowenstine, L. J., Marin III, R., Miller, P. E., McLellan, W. A., Moeller, P. D. R., Powell, C. L., Rowles, T., Silvagni, P., Silver, M., Spraker, T., Trainer, V., and Van Dolah, F. M. 2000. Mortality of sea lions along the central California coast linked to a toxic diatom bloom. Nature, 403:80-84.

Stewart, B. S. and P. K. Yochem. 1987. Entanglement of pinnipeds in synthetic debris and fishing net and line fragments at San Nicolas and San Miguel Islands, California, 1978-1986. Marine Pollution Bulletin 18:336-339.

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HARBOR SEAL (*Phoca vitulina richardsi*): California Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals (*Phoca vitulina*) are widely distributed in the North Atlantic and North Pacific. Two subspecies exist in the Pacific: *P. v. stejnegeri* in the western North Pacific, near Japan, and *P. v. richardsi* in the eastern North Pacific. The latter subspecies inhabits near-shore coastal and estuarine areas from Baja California, Mexico, to the Pribilof Islands in Alaska. These seals do not make extensive pelagic migrations, but do travel 300-500 km on occasion to find food or suitable breeding areas (Herder 1986; D. Hanan unpublished data). In California, approximately 400-500 harbor seal haulout sites are widely distributed along the mainland and on offshore islands, including intertidal sandbars, rocky shores and beaches (Hanan 1996).

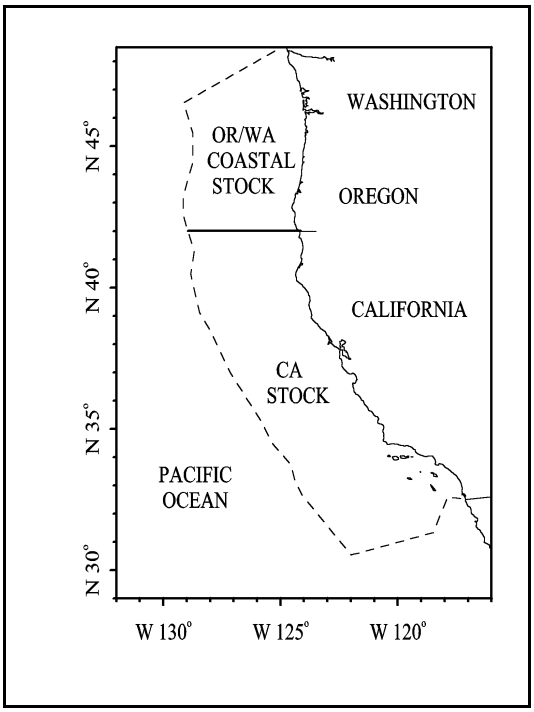

Figure 1. Stock boundaries for the California and Oregon/Washington coastal stocks of harbor seals. Dashed line represents the U.S. EEZ.

Within the subspecies *P. v. richardsi*, abundant evidence of geographic structure comes from differences in mitochondrial DNA (Huber et al. 1994; Burg 1996; Lamont et al. 1996), mean pupping dates (Temte 1986), pollutant loads (Calambokidis et al. 1985), pelage coloration (Kelly 1981) and movement patterns (Jeffries 1985; Brown 1988). LaMont (1996) identified four discrete subpopulation differences in mtDNA between harbor seals from Washington (two locations), Oregon, and California. Another mtDNA study (Burg 1996) supported the existence of three separate groups of harbor seals between Vancouver Island and southeastern Alaska. Although we know that geographic structure exists along an almost continuous distribution of harbor seals from California to Alaska, stock boundaries are difficult to draw because any rigid line is (to a greater or lesser extent) arbitrary from a biological perspective. Nonetheless, failure to recognize geographic structure by defining management stocks can lead to depletion of local populations. Previous assessments of the status of harbor seals have recognized 3 stocks along the west coast of the continental U.S.: 1) California, 2) Oregon and Washington outer coast waters, and 3) inland waters of Washington. Although the need for stock boundaries for management is real and is supported by biological information, the exact placement of a boundary between California and Oregon was largely a political/jurisdictional convenience. A small number of harbor seals also occur along the west coast of Baja California, but they are not considered to be a part of the California stock because no international agreements exist for the joint management of this species by the U.S. and Mexico. Lacking any new information on which to base a revised boundary, the harbor seals of California will be again treated as a separate stock in this report (Fig. 1). Other Marine Mammal Protection Act (MMPA) stock assessment reports cover the five other stocks that are recognized along the U.S. west coast: Oregon/Washington outer coastal waters, Washington inland waters, and three stocks in Alaska coastal and inland waters.

POPULATION SIZE

A complete count of all harbor seals in California is impossible because some are always away from the haulout sites. A complete pup count (as is done for other pinnipeds in California) is also not possible because harbor seals are precocious, with pups entering the water almost immediately after birth. Population size is estimated by counting the number of seals ashore during the peak haul-out period (the May/June molt) and by multiplying this count by the inverse of the estimated fraction of seals on land. Boveng (1988) reviewed studies estimating the proportion of seals hauled out to those in the water and suggested that a correction factor for harbor seals is likely to be between 1.4 and 2.0. Huber (1995) estimated a mean correction factor of 1.53 (CV=0.065) for harbor seals in Oregon and Washington during the peak pupping season. Hanan (1996) estimated that 83.3% (CV=0.17) of harbor seals haul out at some time during

the day during the May/June molt, and he estimated a correction factor of 1.20 based on those data. Neither correction factor is directly applicable to an aerial photographic count in California: the 1.53 factor was measured at the wrong time of year (when fewer seals are hauled out) and in a different area and the 1.20 factor was based on the fraction of seals hauled out over an entire 24 hr day (correction factors for aerial counts should be based on the fraction of seals hauled out at the time of the survey). Hanan (pers. comm.) revised his haul-out correction factor to 1.3 by using only those seals hauled out between 0800 and 1700 which better corresponds to the timing of his surveys. Based on the most recent harbor seal counts (23,302 in May/June 1995, Hanan 1996) and Hanan's revised correction factor, the harbor seal population in California is estimated to number 30,293. A harbor seal count in California was attempted in 1999, but was not successful due to bad weather and camera failure (Hanan, pers. comm.). An aerial survey in May/June 2000 was successful in obtaining a new haul-out estimate for the Channel Islands in southern California (Fig. 2), but weather and other factors precluded a complete survey of the entire state.

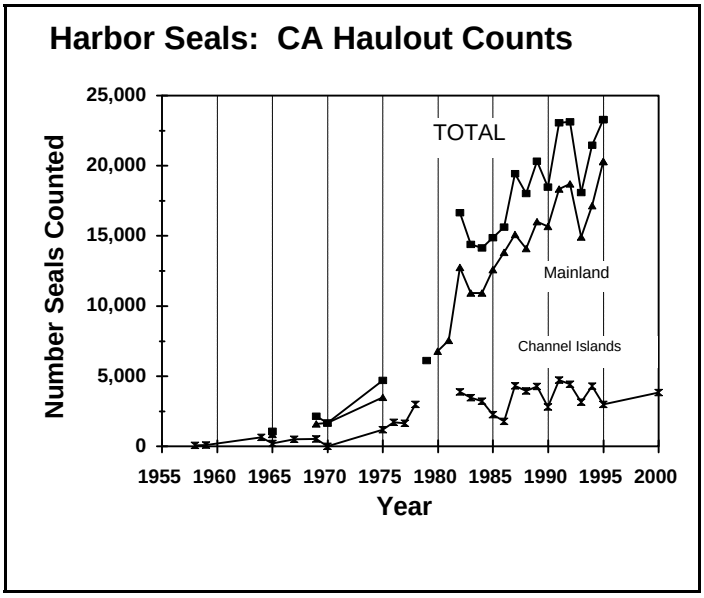

Figure 2. Harbor seal haulout counts in California during May/June (Hanan 1996; R. Read, CDFG unpubl. data).

Minimum Population Estimate

Because of the way it was calculated (based on the fraction of seals hauled out at any time during a 24 hr day), Hanan's (1996) correction factor of 1.2 can be viewed as a minimum estimate of the fraction hauled out at a given instant. A population size estimated using this correction factor provides a reasonable assurance that the true population is greater than or equal to that number, and thus fulfills the requirement of a minimum population estimate. The minimum size of the California harbor seal population is therefore 27,962.

Current Population Trend

Harbor seal counts have continued to increase except during El Niño events (eg. 1992-93) (Fig. 2). The net production appears, however, to be slowing in California (Fig. 3) and in Oregon and Washington (see separate Stock Assessment Report).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A realized rate of increase was calculated for the 1982-1995 period by linear regression of the natural logarithm of total count versus year. The slope this regression line was 0.035 (s.e.=0.007) which gives an annualized growth rate estimate of 3.5%. The current rate of net production is greater than this observed growth rate because fishery mortality takes a fraction of the net production. Annual gillnet mortality may have been as high as 5-10% of the California harbor seal population in

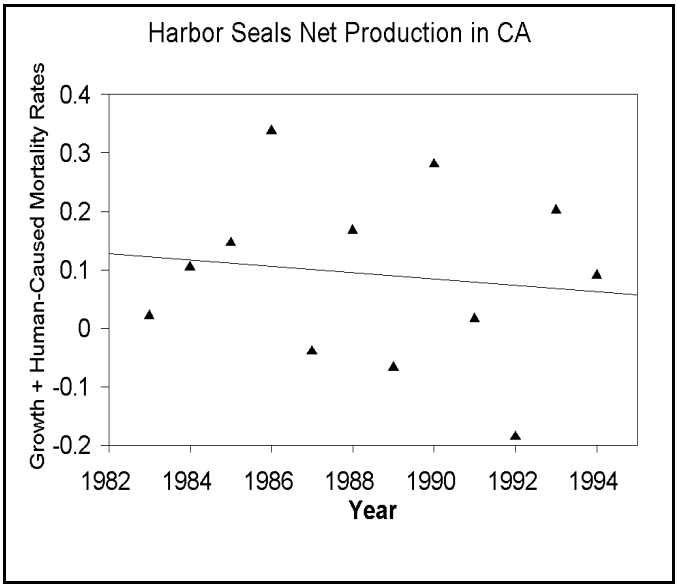

Figure 3. Net production rates and regression line estimated from haulout counts and fishery mortality.

the mid-1980s; a kill this large would have depressed population growth rates appreciably. Net productivity was therefore calculated for 1980-1994 as the realized rate of population growth (increase in seal counts from year *i* to year *i*+1, divided by the seal count in year *i*) plus the human-caused mortality rate (fishery mortality in year *i* divided by population size in year *i*). Between 1983 and 1994, the net productivity rate for the California stock averaged 9.2% (Fig. 3). A regression shows a decrease in net production rates, but the decline is not statistically significant. Maximum net productivity rates cannot be estimated because measurements were not made when the stock size was very small.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (27,962) times one half the default maximum net productivity rate for pinnipeds (½ of 12%) times a recovery factor of 1.0 (for a stock of unknown status that is growing, Wade and Angliss 1997), resulting in a PBR of 1,678.

Table 1. Summary of available information on the mortality and serious injury of harbor seals (California stock) in commercial fisheries that might take this species (NMFS 1995; Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999; 2000). 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	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1995-99	observer data	12-23%	0	0,0,0,0,0	0[1]
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	1995 1996 1997 1998 1999	extrapo-lated estimate observer data	0.0% 0.0% 0.0% 0.0% 4.0%[3]	- - - - 57	228 (0.13)[2] 296 (0.08)[2] 349 (0.08)[2] 392 (0.10)[2] 662 (0.10)[3]	662
CA, OR, and WA salmon troll fishery	1990-92	logbook data	-		Avg. Annual take = 7.33	n/a
CA herring purse seine fishery	1990-92	logbook data	-		Avg. Annual take = 0	n/a
CA anchovy, mackerel, and tuna purse seine fishery	1990-92	logbook data	-		Avg. Annual take = 0.67	n/a
WA, OR, CA groundfish trawl	1991-95	observer data	54-73%	0	0,0,0,0,0	0
CA squid purse seine fishery	1990-92	logbook data	-		Avg. Annual take = 0	n/a
(unknown net and hook fisheries)	1995-98	stranding data		17		4
Total annual takes						666

[1] Only 1997-98 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).

[2]The CA set gillnets were not observed from 1995-98; mortality was extrapolated from effort estimates and previous entanglement rates.

[3]Set gillnet observer coverage in 1999 was limited to Monterey Bay fishing effort only. Mortality in other areas was extrapolated from 1999 effort estimates and 1991-94 entanglement rates.

HUMAN-CAUSED MORTALITY

Historical Takes

Prior to state and federal protection and especially during the nineteenth century, harbor seals along the west coast of North America were greatly reduced by commercial hunting (Bonnot 1928, 1951; Bartholomew and Boolootian 1960). Only a few hundred individuals survived in a few isolated areas along the California coast (Bonnot 1928). In

the last half of this century, the population has increased dramatically.

Fishery Information

A summary of known fishery mortality and injury for this stock of harbor seals is given in Table 1. More detailed information on these fisheries is provided in Appendix 1. Because the vast majority of harbor seal mortality in California fisheries occurs in the set gillnet fishery, because that fishery has undergone dramatic reductions and redistributions of effort, and because the entire fishery has not been observed since 1994, average annual mortality cannot be accurately estimated for the recent years (1995-1999). Rough estimates for 1995-1999 have been made by extrapolation of prior kill rates using recent effort estimates (Table 1). Preliminary gillnet observations from April to September 1999 included 47 harbor seals in 24.6% of the sets for a rough extrapolated estimate of 191 mortalities in this half-year period. Stranding data reported to the California Marine Mammal Stranding Network in 1995-98 include harbor seal deaths and injuries caused by hook-and-line fisheries (17 deaths, 4 injuries) and gillnet fisheries (1 death, 2 injuries).

Other Mortality

The California Marine Mammal Stranding database maintained by the National Marine Fisheries Service, Southwest Region, contains the following records of human-related harbor seal mortalities and injuries in 1995-99: (1) boat collision (11 mortalities, 2 injuries), (2) entrainment in power plants (24 mortalities), and (3) shootings (11 mortalities).

STATUS OF STOCK

A review of harbor seal dynamics through 1991 concluded that their status relative to OSP could not be determined with certainty (Hanan 1996). They are not listed as "endangered" or "threatened" under the Endangered Species Act nor as "depleted" under the MMPA. Total fishing mortality cannot be accurately estimate for recent years, but extrapolations from past years and preliminary data for 1999 indicate that fishing mortality is less than the calculated PBR for this stock (1,678), and thus they would not be considered a "strategic" stock under the MMPA. The average rate of incidental fishery mortality for this stock is likely to be greater than 10% of the calculated PBR; therefore, fishery mortality cannot be considered insignificant and approaching zero mortality and serious injury rate. The population appears to be growing and the fishery mortality is declining. There are no known habitat issues that are of particular concern for this stock. Two unexplained harbor seal mortality events occurred in Point Reyes National Park involving at least 90 seals in 1997 and 16 seals in 2000. Necropsy of 3 seals in 2000 showed severe pneumonia; tests for morbillivirus were negative, but attempts are being made to identify another virus isolated from one of the three (F. Gulland, pers. comm.). All west-coast harbor seals that have been tested for morbilliviruses were found to be seronegative, indicating that this disease is not endemic in the population and that this population is extremely susceptible to an epidemic of this disease (Ham-Lammé et al. 1999).

REFERENCES

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.

Bartholomew, G. A., R. A. Boolootian. 1960. Numbers and population structure of the pinnipeds on the California Channel Islands. J. Mammal. 41:366-375.

Bonnot, P. 1928. Report on the seals and sea lions of California. Fish Bulletin Number 14. California Division of Fish and Game.

Bonnot, P. 1951. The sea lions, seals and sea otter of the California coast. California Fish and Game 37(4):371-389.

Boveng, P. 1988. Status of the Pacific harbor seal population on the U.S. west coast. Admin. Rep. LJ-88-06. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 43 pp.

Brown, R. F. 1988. Assessment of pinniped populations in Oregon. Processed Report 88-05, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, Washington.

Burg, T. M. 1996. Genetic analysis of eastern Pacific harbor seals (*Phoca vitulina richardsi*) from British Columbia and parts of Alaska using mitochondrial DNA and microsatellites. Masters Thesis, Univ. of British Columbia,

Vancouver, British Columbia. 77pp.
Calambokidis, J., S. M. Speich, J. Peard, G. H. Steiger, and J. C. Cubbage. 1985. Biology of Puget Sound marine mammals and marine birds: population health and evidence of pollution effects. U.S. Dep. Commer., NOAA Tech. Memo. NOS-OMA-18. 159 pp.
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.
Cameron, G.A. and K.A. Forney. 2000. Preliminary Estimates of Cetacean Mortality in California/Oregon Gillnet Fisheries for 1999. Paper SC/52/O24 presented to the International Whaling Commission, 2000 (unpublished). 12 pp. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038, USA.
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.
Ham-Lammé, K. D., D. P. King, B. C. Taylor, C. House, D. A. Jessup, S. Jeffries, P. K Yochem, F. M. D. Gulland, D. A. Ferrick, and J. L. Stott. 1999. The application of immuno-assays for serological detection of morbillivirus exposure in free ranging harbor seals (*Phoca vitulina*) and sea otters (*Enhydra lutris*) from the western coast of the United States. Mar. Mamm. Sci. 15(2):601-608.
Hanan, D. A. 1993. Status of the Pacific harbor seal population on the coast of California in 1992. Final Report to the National Marine Fisheries Service, Southwest Region. 27pp.
Hanan, D. A. 1996. Dynamics of Abundance and Distribution for Pacific Harbor Seal, *Phoca vitulina richardsi*, on the Coast of California. Ph.D. Dissertation, University of California, Los Angeles. 158pp.
Hanan, D. A., and S. L. Diamond. 1989. Estimates of sea lion, harbor seal, and harbor porpoise mortalities in California set net fisheries for the 1986-87 fishing year. Final Report. Cooperative agreement No. NA-86-ABH-00018. NOAA/NMFS SWR, January 1989. 10 pages.
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.
Hanan, D. A., J. P. Scholl, and S. L. Diamond. 1988. Estimates of sea lion and harbor seal mortalities in California set net fisheries for 1983, 1984, and 1985. Final Report. Cooperative agreement No. NA-86-ABH-00018. NOAA/NMFS SWR October 1988. 10 pages.
Herder, M. J. 1986. Seasonal movements and hauling site fidelity of harbor seals, *Phoca vitulina richardsi*, tagged at the Russian River, California. MS Thesis. Humbolt State Univ. 52 pages.
Huber, H. 1995. The abundance of harbor seals (*Phoca vitulina richardsi*) in Washington, 1991-1993. MS Thesis, Univ. of Washington, Seattle, Washington. 56 pp.
Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1994. Harbor seal stock assessment in Washington and Oregon 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.
Jeffries, S. J. 1985. Occurrence and distribution patterns of marine mammals in the Columbia River and adjacent coastal waters of northern Oregon and Washington. *In*: Marine Mammals and Adjacent Waters, 1980-1982. Processed Report 85-04, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, Washington.
Julian, F. And M. Beeson. 1998. Estimates for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.
Kelly, B. P. 1981. Pelage polymorphism in Pacific harbor seals. Can. J. Zool. 59:1212-1219.
Lamont, M. M., J. T. Vida, J. T. Harvey, S. Jeffries, R. Brown, H. H. Huber, R. DeLong, and W. K. Thomas. 1996. Genetic substructure of the Pacific harbor seal (*Phoca vitulina richardsi*) off Washington, Oregon, and California. Mar. Mamm. Sci. 12(3):402-413.
Miller, D. J., M. J. Herder, and J. P. Scholl. 1983. California marine mammal-fishery interaction study, 1979-1981. Admin. Rep. LJ-83-13C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 233 pp.
NMFS. 1995. Environmental assessment of proposed regulations to govern interactions between marine mammals and commercial fishing operations, under Section 118 of the Marine Mammal Protection Act. Department of

Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, June 1995. 139 p. + 4 Appendices.

Perkins, P., J. Barlow, and M. Beeson. 1994. Report on pinniped and cetacean mortality in California gillnet fisheries: 1988-90. Admin. Rep. LJ-94-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P. O. Box 271, La Jolla, California, 92038. 16 pp.

Temte, J. L. 1986. Photoperiod and the timing of pupping in the Pacific harbor seal (*Phoca vitulina richardsi*) with notes on reproduction in northern fur seals and Dall's porpoises. Masters Thesis, Oregon State Univ., Corvallis, Oregon.

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HARBOR SEAL (*Phoca vitulina richardsi*): Oregon/Washington Coast Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the continental U.S., British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice, and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944; Fisher 1952; Bigg 1969, 1981). Harbor seals do not make extensive pelagic migrations though some long distance movement of tagged animals in Alaska (174 km) and along the U.S. west coast (up to 550 km) have been recorded (Pitcher and McAllister 1981, Brown and Mate 1983, Herder 1986). Harbor seals have also displayed strong fidelity for haul out sites (Pitcher and Calkins 1979, Pitcher and McAllister 1981).

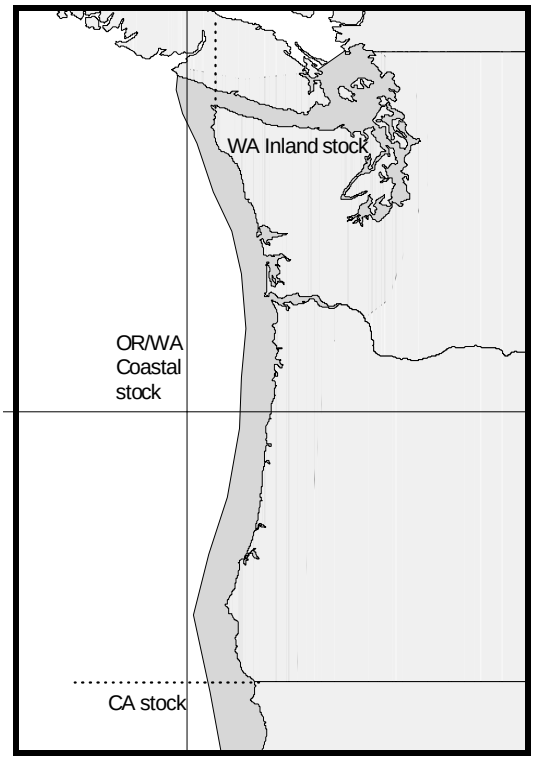

Figure 1. Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

For management purposes, differences in mean pupping date (Temte 1986), movement patterns (Jeffries 1985, Brown 1988), pollutant loads (Calambokidis et al. 1985) and fishery interactions have led to the recognition of 3 separate harbor seal stocks along the west coast of the continental U.S. (Boveng 1988): 1) inland waters of Washington State (including the Hood Canal, Puget Sound, and Strait of Juan de Fuca out to Cape Flattery), 2) outer coast of Oregon and Washington, and 3) California (see Fig. 1). Recent genetic analyses provide additional support for this stock structure (Huber et al. 1994, Burg 1996, Lamont et al. 1996). Samples from Washington, Oregon, and California demonstrate a high level of genetic diversity and indicate that the harbor seals of inland Washington possess unique haplotypes not found in seals from the coasts of Washington, Oregon, and California (Lamont et al. 1996). This report considers only the Oregon/Washington Coast stock. Harbor seal stocks that occur in the inland and coastal waters of Alaska are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Aerial surveys of harbor seals in Oregon and Washington were conducted by personnel from the National Marine Mammal Laboratory (NMML) and the Oregon and Washington Departments of Fish and Wildlife (ODFW and WDFW) during the 1999 pupping season. Total numbers of hauled-out seals (including pups) were counted during these surveys. In 1999, the mean count of harbor seals occurring along the Washington coast was 10,430 (CV=0.14) animals (Jeffries et al. in press). In 1999, the mean count of harbor seals occurring along the Oregon coast and in the Columbia River was 5,735 (CV=0.14) animals (Brown 1997; ODFW, unpubl. data). Combining these counts results in 16,165 (CV=0.10) harbor seals in the Oregon/Washington Coast stock.

Radio-tagging studies conducted at 6 locations (3 Washington inland waters sites and 3 Oregon and Washington coastal sites) collected information on haulout patterns from 63 harbor seals in 1991 and 61 harbor seals in 1992. Data from coastal and inland sites were not significantly different and were thus pooled, resulting in a correction factor of 1.53 (CV=0.065) to account for animals in the water which are missed during the aerial surveys (Huber et al. 2001). Using this correction factor results in a population estimate of 24,732 (16,165 x 1.53; CV=0.12)

for the Oregon/Washington Coast stock of harbor seals in 1999 (Jeffries et al. in press; ODFW, unpubl. data).

Minimum Population Estimate

The log-normal 20th percentile of the 1999 population estimate for this stock is 22,380 harbor seals.

Current Population Trend

Historical levels of harbor seal abundance in Oregon and Washington are unknown. The population apparently decreased during the 1940s and 1950s due to state-financed bounty programs. Approximately 17,133 harbor seals were killed in Washington by bounty hunters between 1943 and 1960 (Newby 1973). More than 3,800 harbor seals were killed in Oregon between 1925 and 1972 by bounty hunters and a state-hired seal hunter (Pearson 1968). The population remained relatively low during the 1960s but, since the termination of the harbor seal bounty program and with the protection provided by the passage of the Marine Mammal Protection Act (MMPA) in 1972, harbor seal counts for this stock have increased from 6,389 in 1977 to 16,165 in 1999 (Jeffries et al. in press; ODFW, unpubl. data).

Between 1983 and 1996, the annual rate of increase for this stock was 4%, with the peak count of 18,667 seals occurring in 1992. From 1991 to 1996, however, this stock declined 1.6% (t=3.25; p=0.083) annually (Jeffries et al. 1997), which may indicate that this population has exceeded equilibrium levels. Analyzing only the Oregon data (average annual rate of increase was 0.3% from 1988-96) indicates that the Oregon segment of the stock may be approaching equilibrium (Brown 1997).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The Oregon/Washington Coast harbor seal stock increased at an annual rate of 7% from 1983 to 1992 and at 4% from 1983 to 1996 (Jeffries et al. 1997). Because the population was not at a very low level by 1983, the observed rates of increase may underestimate the maximum net productivity rate (R_{MAX}). When a logistic model was fit to the Washington portion of the 1975-1999 abundance data, the resulting estimate of R_{MAX} was18.5% (95% CI = 12.9-26.8%) (Jeffries et al. in press). This value of R_{MAX} is higher than the pinniped default value of 12%; however, since it applies to only a portion of the stock, the actual rate for the entire stock is uncertain. Therefore, until additional data for the entire stock become available, the pinniped default maximum theoretical net productivity rate (R_{MAX}) of 12% will be employed for this harbor seal stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population estimate (22,380) times one-half the default maximum net growth rate for pinnipeds (½ of 12%) times a recovery factor of 1.0 (for stocks thought to be within OSP, Wade and Angliss 1997), resulting in a PBR of 1,343 harbor seals per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

NMFS observers monitored the northern Washington marine set gillnet fishery during 1994-1998 and in 2000; there was no observer coverage in 1999, however, the total fishing effort was only 4 net days in inland waters (Gearin et al. 1994, 2000; P. Gearin, unpubl. data). For the entire fishery (coastal + inland waters), observer coverage ranged from approximately 33 to 98% during observed years. Fishing effort is conducted within the range of both stocks of harbor seals (Oregon/Washington Coast and Washington Inland Waters stocks) occurring in Washington State waters. For the purposes of this stock assessment report, the animals taken in the inland portion of the fishery are assumed to have belonged to the Washington Inland Waters stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon/Washington Coast stock. Some movement of animals between Washington's coastal and inland waters is likely, although data from tagging studies have not shown movement of harbor seals between the two locations (Huber et al. 2001). Accordingly, Table 1 includes data only from that portion of the northern Washington marine set gillnet fishery occurring within the range of the Oregon/Washington Coast stock (those waters south and west of Cape Flattery), where observer coverage was 30% in 1994 and 100% in 1995-1997 and 2000. In 1994, the observer program was delayed because the biological opinion on the fishery, relating to takes of marbled murrelets under the ESA, was not completed by the time the fishery began. One vessel fished in the coastal fishery in 1994 and 30% of the sets were observed. No fishing effort occurred in the coastal portion of the fishery in 1998 or 1999. Data from 1994 to 2000 are included in Table 1, although the mean estimated annual mortality is calculated using

only the most recent 5 years for which data are available. The mean estimated mortality for this fishery is 5 (CV=0.52) harbor seals per year from this stock.

The WA/OR/CA groundfish trawl fishery (Pacific whiting component) was monitored for incidental take during 1996-2000. The only harbor seal mortalities occurred in 1996, 1997, and 2000. The mortalities in 1996 and 1997 occurred during unmonitored hauls and therefore were not used to estimate mortality for the entire fishery in those years. However, observer coverage (based on observed tons) was 65% and 66% (respectively) in 1996 and 1997, observers monitored 100% of the vessels during the fishery, and the reported mortalities are thought to be the only harbor seal mortalities in the fishery in those years. The mean estimated mortality in 1996-2000 for monitored hauls in this fishery is 0.8 (CV=1.0) harbor seals per year from this stock, plus 0.4 animals per year from unmonitored haul data.

Table 1. Summary of available information on the incidental mortality and injury of harbor seals (Oregon/Washington Coast stock) in commercial and tribal fisheries that might take this species and calculation of the mean annual mortality rate; n/a indicates that data are not available. All entanglements resulted in the death of the animal. Mean annual takes are based on 1996-2000 data unless otherwise noted.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery: coastal waters)	94 95 96 97 98 99 00	obs data	30% 100% 100% 100% no fishery no fishery 100%	4 3 9 13 0 0 3	13 3 9 13 0 0 3	5 (0.52)
WA/OR/CA groundfish trawl (Pacific whiting component)	96 97 98 99 00 96 97	obs data unmonitored hauls	65.2% 65.7% 77.3% 68.6% 80.6%	0 0 0 0 2 1 1	0 0 0 0 4	0.8 (1.0) 0.4 (n/a)
WA Grays Harbor salmon drift gillnet	91-93	obs data	4-5%	0, 1, 1	0, 10, 10	6.7 (0.50)
WA Willapa Bay drift gillnet	91-93	obs data	1-3%	0, 0, 0	0, 0, 0	0
				Reported mortalities		
WA Willapa Bay drift gillnet	90-00	self reports	n/a	0, 0, 6, 8, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	$\geq$ 3.5 (n/a) see text
Unknown west coast fisheries	96-00	strand data	n/a	0, 0, 0, 1, 0		$\geq$ 0.2 (n/a)
Minimum total annual takes						$\geq$ 16.6 (0.35)

The Washington and Oregon Lower Columbia River drift gillnet fishery was monitored during the entire year in 1991-1993 (Brown and Jeffries 1993, Matteson et al. 1993c, Matteson and Langton 1994a). Harbor seal mortalities, incidental to the fishery, were observed only in the winter season and were extrapolated to estimate total harbor seal mortality. However, the structure of the fishery has changed substantially since the 1991-1992 fishing seasons, and this level of take no longer applies to the current fishery (see Appendix 1).

The Washington Grays Harbor salmon drift gillnet fishery was also monitored in 1991-1993 (Herczeg et al. 1992a; Matteson and Molinaar 1992; Matteson et al. 1993a; Matteson and Langton 1994b, 1994c). During the 3-year period, 98, 307 and 241 sets were monitored, representing approximately 4-5% observer coverage in each year. No mortalities were recorded in 1991. In 1992, observers recorded one harbor seal mortality incidental to the fishery, resulting in an extrapolated estimated total kill of 10 seals (CV=1.0). In 1993, observers recorded one harbor seal mortality incidental to the fishery, though a total kill was not extrapolated. Similar observer coverage in 1992 and 1993 (4.2% and 4.4%, respectively) suggests that 10 is also a reasonable estimate of the total kill in 1993. Thus, the mean estimated mortality for this fishery in 1991-1993 is 6.7 (CV=0.50) harbor seals per year (Table 1). No observer data are available for this fishery after 1993, however, harbor seal takes are unlikely to have increased since the fishery was last observed, due to reductions in the number of participating vessels and available fishing time (see details in Appendix 1). Fishing effort and catch have declined throughout all salmon fisheries in the region due to management efforts to recover ESA-listed salmonids.

Combining the estimates from the northern Washington marine set gillnet (5), WA/OR/CA groundfish trawl (0.8 from monitored hauls + 0.4 from unmonitored haul data), and Washington Grays Harbor salmon drift gillnet (6.7) fisheries results in an estimated mean mortality rate in observed fisheries of 12.9 harbor seals per year from this stock.

The Washington Willapa Bay drift gillnet fishery was also monitored at low levels of observer coverage in 1991-1993 (Herczeg et al. 1992a, 1992b; Matteson and Molinaar 1992; Matteson et al. 1993b; Matteson and Langton 1994c, 1994d). In those years, 752, 576 and 452 sets were observed, representing approximately 2.5%, 1.4% and 3.1% observer coverage, respectively. No harbor seal mortalities were reported by observers. However, because mortalities were self-reported by fishers in 1992 and 1993, the low level of observer coverage failed to document harbor seal mortalities which had apparently occurred. Due to the low level of observer coverage for this fishery, the self-reported fishery mortalities have been included in Table 1 and represent a minimum mortality estimate resulting from that fishery (3.5 harbor seals per year). Harbor seal takes are unlikely to have increased since the fishery was last observed in 1993, due to reductions in the number of participating vessels and available fishing time (see details in Appendix 1). Fishing effort and catch have declined throughout all salmon fisheries in the region due to management efforts to recover ESA-listed salmonids.

An additional source of information on the number of harbor seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1994 and 2000, there were no fisher self-reports of any harbor seal mortalities. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-1995 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 in Angliss et al. 2001 for details).

Strandings of harbor seals entangled in fishing gear or with injuries caused by interactions with gear are a final source of fishery-related mortality information. One fishery-related stranding was reported in 1999 and, since it could not be attributed to a particular fishery, it is listed in Table 1 as occurring in an unknown west coast fishery. Fishery-related strandings during 1996-2000 resulted in an estimated annual mortality of 0.2 harbor seals from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

Other Mortality

According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region, a total of 6 human-caused harbor seal mortalities or serious injuries were reported from non-fisheries sources in 1996-2000. Five animals were shot (1 each in 1997, 1999, and 2000 and 2 in 1998) and one animal was struck by an off-road-vehicle (in 1997), resulting in an estimated mortality of 1.2 harbor seals per year from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

Subsistence Harvests by Northwest Treaty Indian Tribes

Several Pacific Northwest treaty Indian tribes have promulgated tribal regulations allowing tribal members to

exercise treaty rights for subsistence harvest of harbor seals. There have been only a few reported takes of harbor seals from directed tribal subsistence hunts. It is possible that very few seals have been taken in directed hunts because tribal fishers use seals caught incidentally to fishing operations for their subsistence needs before undertaking a ceremonial or subsistence hunt. From communications with the tribes, the NMFS Northwest Regional Office (J. Scordino, pers. comm.) believes that 5-10 harbor seals from this stock may be taken annually in directed subsistence harvests.

STATUS OF STOCK

Harbor seals are not considered as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the level of human-caused mortality and serious injury (16.6 + 1.2 + 5-10 = 22.8-27.8) is not known to exceed the PBR (1,343). Therefore, the Oregon/Washington Coast stock of harbor seals is not classified as a "strategic" stock. The minimum total fishery mortality and serious injury for this stock (16.6: based on observer data (12.9) and self-reported fisheries information (3.5) or stranding data (0.2) where observer data were not available or failed to detect harbor seal mortality) appears to be less than 10% of the calculated PBR (134) and, therefore, appears to be insignificant and approaching zero mortality and serious injury rate. The stock size increased until 1992, but has declined in recent years. At this time it is not possible to assess the status of this stock relative to its Optimum Sustainable Population (OSP) level.

REFERENCES

Angliss, R.P., D.P. DeMaster, and A.L. Lopez. 2001. Alaska marine mammal stock assessments, 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-124. 203 pp.

Bigg, M. A. 1969. The harbour seal in British Columbia. Fish. Res. Bd. Can. Bull. 172. 33 pp.

Bigg, M. A. 1981. Harbour seal, *Phoca vitulina*, Linnaeus, 1758 and *Phoca largha*, Pallas, 1811. Pp. 1-27, *In:* Ridgway, S. H., and R. J. Harrison (eds.), Handbook of Marine Mammals. Vol. 2: Seals. Academic Press, New York.

Boveng, P. 1988. Status of the Pacific harbor seal population on the U.S. west coast. Admin. Rept. LJ-88-06. Southwest Fisheries Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 43 pp.

Brown, R. F. 1988. Assessment of pinniped populations in Oregon. Processed Report 88-05, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, WA.

Brown, R. F. 1997. Abundance of Pacific harbor seals (*Phoca vitulina richardsi*) in Oregon: 1977-1996. Oregon Dept. Fish and Wildlife, Wildlife Diversity Program, Tech. Report No. 97-6-04. 12 pp.

Brown, R. F., and S. J. Jeffries. 1993. Preliminary report on estimated marine mammal mortality in Columbia River fall and winter salmon gillnet fisheries, 1991-1992. Unpubl. report. Columbia River Area Gillnet Fishery Observer Program. 13 pp. Available at Oregon Dept. Fish and Wildlife, Newport, OR 97365.

Brown, R. F., and B. R. Mate. 1983. Abundance, movements, and feeding habits of the harbor seal, *Phoca vitulina*, at Netarts and Tillamook Bays, Oregon. Fish. Bull. 81:291-301.

Burg, T. M. 1996. Genetic analysis of eastern Pacific harbor seals (*Phoca vitulina richardsi*) from British Columbia and parts of Alaska using mitochondrial DNA and microsatellites. MS Thesis, Univ. of British Columbia, Vancouver, BC. 77 pp.

Calambokidis, J., S. Speich, J. Peard, G. Steiger, D. M. Fry, J. Lowenstine, and J. Cubbage. 1985. Biology of Puget Sound marine mammals and marine birds: population health and evidence of pollution effects. U.S. Dep. Commer., NOAA Tech. Memo. NOS-OMA-18. 159 pp.

Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Fisher, H. D. 1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. Fish. Res. Bd. Can. Bull. 93. 58 pp.

Gearin, P. J. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Gearin, P. J., S. R. Melin, R. L. DeLong, H. Kajimura, and M. A. Johnson. 1994. Harbor porpoise interactions with a chinook salmon set-net fishery in Washington State. Rep. Int. Whal. Commn. Special Issue 15:427-438.

Gearin, P. J., M. E. Gosho, J. L. Laake, L. Cooke, R. L. DeLong, and K. M. Hughes. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the state of Washington. J. Cetacean Res. Manage. 2(1):1-9.

Herczeg, K. M., A. A. Abajian , and V. M. C. Molinaar. 1992a. Summary report on the 1991 summer dip-in salmon gillnet fisheries in Willapa Bay and Grays Harbor. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 10 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Herczeg, K. M., V. M. C. Molinaar, and A. A. Abajian. 1992b. Summary report on the 1991 fall Willapa Bay salmon gillnet fishery. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 10 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Herder, M. J. 1986. Seasonal movements and hauling site fidelity of harbor seals, *Phoca vitulina richardsi*, tagged at the Russian River, California. MS Thesis, Humbolt State Univ., Humbolt, California. 52 pp.

Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1994. Harbor seal, *Phoca vitulina richardsi*, stock assessment in Washington and Oregon, 1993. 1993 Annual Report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Huber, H. R., S. J. Jeffries, R. F. Brown, R. L. DeLong, and G. VanBlaricom. 2001. Correcting aerial survey counts of harbor seals (*Phoca vitulina richardsi*) in Washington and Oregon. Mar. Mammal. Sci. 17(2):276-293.

Jeffries, S. J. 1985. Occurrence and distribution patterns of marine mammals in the Columbia River and adjacent coastal waters of northern Oregon and Washington. *In*: Marine mammals and adjacent waters, 1980-1982. Processed Report 85-04, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, WA.

Jeffries, S. J., R. F. Brown, H. R. Huber, and R. L. DeLong. 1997. Assessment of harbor seals in Washington and Oregon, 1996. Pp. 83-94, *In:* Hill, P. S., and D. P. DeMaster (eds.), MMPA and ESA Implementation Program, 1996. AFSC Processed Report 97-10. 255 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Jeffries, S., H. Huber, J. Calambokidis, and J. Laake. In press. Trends and status of harbor seals in Washington State: 1978-1999. J. Wildl. Manage.

Lamont, M. M., J. T. Vida, J. T. Harvey, S. Jeffries, R. Brown, H. H. Huber, R. DeLong, and W. K. Thomas. 1996. Genetic substructure of the Pacific harbor seal (*Phoca vitulina richardsi*) off Washington, Oregon, and California. Mar. Mammal Sci. 12(3):402-413.

Matteson, K. M., and J. A. Langton. 1994a. Summary report on the 1993 fall Columbia River salmon gillnet fishery. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 19 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Matteson, K. M., and J. A. Langton. 1994b. Summary report on the 1993 fall Grays Harbor salmon gillnet fishery. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 18 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Matteson, K. M., and J. A. Langton. 1994c. Summary report on the 1993 summer dip-in salmon gillnet fisheries in Willapa Bay and Grays Harbor. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 22 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Matteson, K. M., and J. A. Langton. 1994d. Summary report on the 1993 fall Willapa Bay salmon gillnet fishery. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 18 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Matteson, K. M., and V. M. C. Molinaar. 1992. Summary report on the 1992 summer dip-in salmon gillnet fisheries in Willapa Bay and Grays Harbor. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 13 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Matteson, K. M., W. B. Barnett, and J. A. Langton. 1993a. Summary report on the 1992 fall Grays Harbor salmon gillnet fishery. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 17 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Matteson, K. M., W. B. Barnett, and J. A. Langton. 1993b. Summary report on the 1992 fall Willapa Bay salmon gillnet fishery. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 17 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Matteson, K. M., J. A. Langton, and R. L. Hadley. 1993c. Summary report on the 1993 winter Columbia River salmon gillnet fishery. Unpubl. report. Pacific States Marine Fisheries Commission, Astoria, OR. 29 pp. Available at PSMFC, 45 SE 82nd Ave., Ste. 100, Gladstone, OR 97027.

Newby, T. C. 1973. Changes in Washington State harbor seal population, 1942-1972. Murrelet 54:5-6.

Oregon Department of Fish and Wildlife, Marine Science Dr., Bldg. 3, Newport, OR 97365.
Pearson, J. P. 1968. The abundance and distribution of harbor seals and Steller sea lions in Oregon. MS Thesis, Oregon State Univ., Corvallis, OR. 23 pp.
Pitcher, K. W., and D. G. Calkins. 1979. Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 19(1983):231-310.
Pitcher, K. W., and D. C. McAllister. 1981. Movements and haul out behavior of radio-tagged harbor seals, *Phoca vitulina*. Can. Field Nat. 95:292-297.
Scheffer, V. B., and J. W. Slipp. 1944. The harbor seal in Washington State. Amer. Midl. Nat. 32:373-416.
Scordino, J. National Marine Fisheries Service, Northwest Region, 7600 Sand Point Way NE, Seattle, WA 98115.
Temte, J. L. 1986. Photoperiod and the timing of pupping in the Pacific harbor seal (*Phoca vitulina richardsi*) with notes on reproduction in northern fur seals and Dall's porpoises. MS Thesis, Oregon State Univ. Corvallis, OR.
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.

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HARBOR SEAL (*Phoca vitulina richardsi*): Washington Inland Waters Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the continental U.S., British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice, and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944; Fisher 1952; Bigg 1969, 1981). Harbor seals do not make extensive pelagic migrations though some long distance movement of tagged animals in Alaska (174 km) and along the U.S. west coast (up to 550 km) have been recorded (Pitcher and McAllister 1981, Brown and Mate 1983, Herder 1986). Harbor seals have also displayed strong fidelity for haul out sites (Pitcher and Calkins 1979, Pitcher and McAllister 1981).

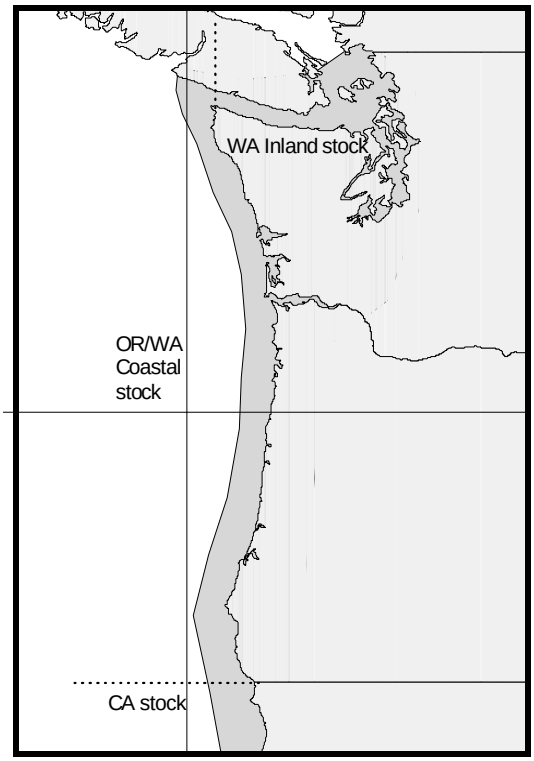

Figure 1. Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

For management purposes, differences in mean pupping date (Temte 1986), movement patterns (Jeffries 1985, Brown 1988), pollutant loads (Calambokidis et al. 1985) and fishery interactions have led to the recognition of 3 separate harbor seal stocks along the west coast of the continental U.S. (Boveng 1988): 1) inland waters of Washington State (including the Hood Canal, Puget Sound, and Strait of Juan de Fuca out to Cape Flattery), 2) outer coast of Oregon and Washington, and 3) California (see Fig. 1). Recent genetic analyses provide additional support for this stock structure (Huber et al. 1994, Burg 1996, Lamont et al. 1996). Samples from Washington, Oregon, and California demonstrate a high level of genetic diversity and indicate that the harbor seals of inland Washington possess unique haplotypes not found in seals from the coasts of Washington, Oregon, and California (Lamont et al. 1996). This report considers only the Washington Inland Waters stock. Harbor seal stocks that occur in the inland and coastal waters of Alaska are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Aerial surveys of harbor seals in Washington were conducted during the pupping season in 1999, during which time the total number of hauled-out seals (including pups) were counted. In 1999, the mean count of harbor seals occurring in Washington's inland waters was 9,550 (CV=0.14) animals (Jeffries et al. in press).

Radio-tagging studies conducted at 6 locations (3 Washington inland waters sites and 3 Oregon and Washington coastal sites) collected information on haulout patterns from 63 harbor seals in 1991 and 61 harbor seals in 1992. Data from coastal and inland sites were not significantly different and were thus pooled, resulting in a correction factor of 1.53 (CV=0.065) to account for animals in the water which are missed during the aerial surveys (Huber et al. 2001). Using this correction factor results in a population estimate of 14,612 (9,550 x 1.53; CV=0.15) for the Washington Inland Waters stock of harbor seals (Jeffries et al. in press).

Minimum Population Estimate

The log-normal 20th percentile of the 1999 population estimate for this stock is 12,844 harbor seals.

Current Population Trend

Historical levels of harbor seal abundance in Washington are unknown. The population apparently decreased during the 1940s and 1950s due to a state-financed bounty program. Approximately 17,133 harbor seals were killed in Washington by bounty hunters between 1943 and 1960 (Newby 1973). The population remained relatively low during the 1970s but, since the termination of the harbor seal bounty program in 1960 and with the protection provided by the passage of the Marine Mammal Protection Act (MMPA) in 1972, harbor seal numbers in Washington have increased (Jeffries 1985).

Between 1983 and 1996, the annual rate of increase for this stock was 6%. From 1991 to 1996, this stock increased 10% (t=5.28; p=0.034) annually, with the peak count occurring in 1996. The higher rate of increase in recent years may be due to emigration of harbor seals from the Canadian waters of the Strait of Georgia to the San Juan Islands (Jeffries et al. 1997).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

From 1991 to 1996, counts of harbor seals in Washington State have increased at an annual rate of 10% (Jeffries et al. 1997). Because the population was not at a very low level by 1991, the observed rate of increase may underestimate the maximum net productivity rate (R_{MAX}). When a logistic model was fit to the 1978-1999 abundance data, the resulting estimate of R_{MAX} was12.6% (95% CI = 9.4-18.7%) (Jeffries et al. in press). This value of R_{MAX} is very close to the pinniped default value of 12%, therefore, the pinniped default maximum theoretical net productivity rate (R_{MAX}) of 12% will be employed for this harbor seal stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (12,844) times one-half the default maximum net growth rate for pinnipeds (½ of 12%) times a recovery factor of 1.0 (for stocks of unknown status that are increasing in size, Wade and Angliss 1997), resulting in a PBR of 771 harbor seals per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

NMFS observers monitored the northern Washington marine set gillnet fishery during 1994-1998 and in 2000; there was no observer coverage in 1999 (Gearin et al. 1994, 2000; P. Gearin, unpubl. data). For the entire fishery (coastal + inland waters), observer coverage ranged from approximately 33 to 98% during observed years. Fishing effort is conducted within the range of both stocks of harbor seals (Oregon/Washington Coast and Washington Inland Waters stocks) occurring in Washington State waters. For the purposes of this stock assessment report, the animals taken in the inland portion of the fishery are assumed to have belonged to the Washington Inland Waters stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon/Washington Coast stock. Some movement of animals between Washington's coastal and inland waters is likely, although data from tagging studies have not shown movement of harbor seals between the two locations (Huber et al. 2001). Accordingly, Table 1 includes data only from that portion of the northern Washington marine set gillnet fishery occurring within the range of the Washington Inland Waters stock (those waters east of Cape Flattery), where observer coverage ranged from 6 to 80% between 1994 and 2000. From 1990 to 1993, fishing effort ranged from 215-469 net days per year (1 net day equals a 100-fathom length net set for 24 hours) in the inland portion of the fishery. Fishing effort decreased in subsequent years, ranging from 4-39 net days per year in 1994-2000, except in 1996 when effort equaled 99 net days. In 1994, the observer program was delayed because the biological opinion on the fishery, relating to takes of marbled murrelets under the ESA, was not completed by the time the fishery began. One vessel fished in both the coastal and inland portions of the fishery in 1994 and 39% of the sets in the inland fishery were observed. Although no harbor seal mortalities were observed in the inland fishery, the vessel operator reported 24 harbor seal mortalities before the observer program began. Since it could not be determined whether these animals were taken in the inland or coastal part of the fishery, half of the mortalities (12) were attributed to the inland portion of the fishery and listed as self reported data in Table 1. There was no observer program in 1999, however, the total fishing effort was only 4 net days

(in inland waters) and no marine mammal takes were reported. Data from 1994-2000 are included in Table 1, although the mean estimated annual mortality is calculated using the most recent 5 years of available data. No harbor seal mortalities were observed or reported in this fishery from 1995 to 2000. The mean estimated mortality for this fishery is zero harbor seals per year from this stock.

In 1993, as a pilot for future observer programs, NMFS in conjunction with the Washington Department of Fish and Wildlife (WDFW) monitored all non-treaty components of the Washington Puget Sound Region salmon gillnet fishery (Pierce et al. 1994). Observer coverage was 1.3% overall, ranging from 0.9% to 7.3% for the various components of the fishery. Two harbor seal mortalities were reported (Table 1). Pierce et al. (1994) cautioned against extrapolating these mortalities to the entire Puget Sound fishery due to the low observer coverage and potential biases inherent in the data. The area 7/7A sockeye landings represented the majority of the non-treaty salmon landings in 1993, approximately 67%. Results of this pilot study were used to design the 1994 observer programs discussed below.

Table 1. Summary of available information on the incidental mortality and injury of harbor seals (Washington Inland Waters stock) in commercial and tribal fisheries that might take this species and calculation of the mean annual mortality rate; n/a indicates that data are not available. All entanglements resulted in the death of the animal. Mean annual takes are based on 1996-2000 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery: inland waters)	94 95 96 97 98 99 00 94-00	obs data self reports	39% 24% 6% 80% 40% 0% 58% 	0 0 0 0 0 n/a 0 12, 0, 0, 0, 0, 0, 0	0 0 0 0 0 n/a 0 	0[1] 0
WA Puget Sound Region salmon set/drift gillnet (observer programs listed below covered segments of this fishery):	-	-	-	-	-	-
Puget Sound non-treaty salmon gillnet (all areas and species)	93	obs data	1.3%	2	n/a	see text
Puget Sound non-treaty chum salmon gillnet (areas 10/11 and 12/12B)	94	obs data	11%	1	10	10 (n/a)
Puget Sound treaty chum salmon gillnet (areas 12, 12B, and 12C)	94	obs data	2.2%	0	0	0
Puget Sound treaty chum and sockeye salmon gillnet (areas 4B, 5, and 6C)	94	obs data	7.5%	0	0	0
Puget Sound treaty and non-treaty sockeye salmon gillnet (areas 7 and 7A)	94	obs data	7%	1	15	15 (1.0)
				Reported mortalities		
WA Puget Sound Region salmon set/drift gillnet	94-00	self reports	n/a	n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	see text

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
WA salmon net pens	97-00	self reports	n/a	10, 5, 0, 0	n/a	$\geq$ 3.8 (n/a)
Unknown Puget Sound fishery	96-00	strand data	n/a	2, 1, 1, 0, 2	n/a	$\geq$ 1.2 (n/a)
Minimum total annual takes						$\geq$ 30 (1.0)

[1]1995-98 and 2000 mortality estimates are included in the average.

In 1994, NMFS in conjunction with WDFW conducted an observer program during the Puget Sound non-treaty chum salmon gillnet fishery (areas 10/11 and 12/12B). A total of 230 sets were observed during 54 boat trips, representing approximately 11% observer coverage of the 500 fishing boat trips comprising the total effort in this fishery, as estimated from fish ticket landings (Erstad et al. 1996). One harbor seal was taken in the fishery, resulting in an entanglement rate of 0.02 harbor seals per trip (0.004 harbor seals per set), which extrapolated to approximately 10 mortalities for the entire fishery. The Puget Sound treaty chum salmon gillnet fishery in Hood Canal (areas 12, 12B, and 12C) and the Puget Sound treaty sockeye/chum gillnet fishery in the Strait of Juan de Fuca (areas 4B, 5, and 6C) were also monitored in 1994 (NWIFC 1995). No harbor seal mortalities were reported in the observer programs covering these treaty salmon gillnet fisheries, where observer coverage was estimated at 2.2% (based on % of total catch observed) and approximately 7.5% (based on % of observed trips to total landings), respectively.

Also in 1994, NMFS in conjunction with WDFW and the Tribes monitored the Puget Sound treaty and non-treaty sockeye salmon gillnet fishery (areas 7 and 7A). During this fishery, observers monitored 2,205 sets, representing approximately 7% of the estimated number of sets in the fishery (Pierce et al. 1996). There was one observed harbor seal mortality (two others were entangled and released unharmed), resulting in a mortality rate of 0.00045 harbor seals per set, which extrapolated to 15 mortalities (CV=1.0) for the entire fishery.

In 1996, Washington Sea Grant Program conducted a test fishery in the non-treaty sockeye salmon gillnet fishery (area 7) to compare entanglement rates of seabirds and marine mammals and catch rates of salmon using three experimental gears and a control (monofilament mesh net). The experimental nets incorporated highly visible mesh in the upper quarter (50 mesh gear) or upper eighth (20 mesh gear) of the net or had low-frequency sound emitters attached to the corkline (Melvin et al. 1997). In 642 sets during 17 vessel trips, there were two harbor seal mortalities (one other was released alive with no apparent injuries).

Combining the estimates from the northern Washington marine set gillnet (0) fishery, the Puget Sound non-treaty chum salmon gillnet fishery in areas 10/11 and 12/12B (10), and the Puget Sound treaty and non-treaty sockeye salmon gillnet fishery in areas 7 and 7A (15) results in an estimated minimum annual mortality rate in observed fisheries of 25 harbor seals from this stock. It should be noted that the 1994 observer programs did not sample all segments of the entire Washington Puget Sound Region salmon set/drift gillnet fishery and, further, the extrapolations of total kill did not include effort for the unobserved segments of this fishery. Therefore, 25 is an underestimate of the harbor seal mortality due to the entire fishery. The percentage of the overall Washington Puget Sound Region salmon set/drift gillnet fishery effort that was observed in 1994 was not quantified. However, the areas having the highest salmon catches and in which a majority of the vessels operated in 1994 were covered by the 1994 observer programs (J. Scordino, pers. comm.). Harbor seal takes in the Washington Puget Sound Region salmon drift gillnet fishery are unlikely to have increased since the fishery was last observed in 1994, due to reductions in the number of participating vessels and available fishing time (see details in Appendix 1). Fishing effort and catch have declined throughout all salmon fisheries in the region due to management efforts to recover ESA-listed salmonids.

An additional source of information on the number of harbor seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. Fisher self-reports from 1994-2000 for the Washington Puget Sound Region salmon set/drift gillnet fishery are shown in Table 1. Unlike the 1994 observer program data, the self-reported fishery data cover the entire fishery (including treaty and non-treaty components) and have thus been included in the table. There were fisher self-reports of 15 harbor seal mortalities due to entanglement in Washington salmon net pens in 1997-2000, 10 in 1997 and 5 in 1998 (Table 1), resulting in an

estimated annual mortality of 3.8 harbor seals from this stock. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-1995 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 in Angliss et al. 2001 for details).

Strandings of harbor seals entangled in fishing gear or with injuries caused by interactions with gear are a final source of fishery-related mortality information. During the period from 1996 to 2000, small numbers of fishery-related strandings of harbor seals have occurred in most years. As the strandings could not be attributed to a particular fishery, they have been included in Table 1 as occurring in an unknown Puget Sound fishery. Fishery-related strandings during 1996-2000 resulted in an estimated annual mortality of 1.2 harbor seals from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

The minimum estimated fishery mortality and serious injury for this stock is 30 harbor seals per year, based on observer program data (25), fisher self-reports (3.8), and stranding data (1.2).

Other Mortality

According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region, a total of 20 human-caused harbor seal mortalities or serious injuries were reported from non-fisheries sources in 1996-2000. Seventeen animals were shot (4, 7, 2, 1 and 3 each year, respectively), 1 was struck by a ship, and 2 had head or neck injuries, resulting in an estimated mortality of 4 harbor seals per year from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or cause of death determined (via necropsy by trained personnel).

Subsistence Harvests by Northwest Treaty Indian Tribes

Several Pacific Northwest treaty Indian tribes have promulgated tribal regulations allowing tribal members to exercise treaty rights for subsistence harvest of harbor seals. There have been only a few reported takes of harbor seals from directed tribal subsistence hunts. It is possible that very few seals have been taken in directed hunts because tribal fishers use seals caught incidentally to fishing operations for their subsistence needs before undertaking a ceremonial or subsistence hunt. From communications with the tribes, the NMFS Northwest Regional Office (J. Scordino, pers. comm.) believes that 0-5 harbor seals from this stock may be taken annually in directed subsistence harvests.

STATUS OF STOCK

Harbor seals are not considered to be "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the level of human-caused mortality and serious injury (30 + 4 + 0-5 = 34-39) is not known to exceed the PBR (771). Therefore, the Washington Inland Waters stock of harbor seals is not classified as a "strategic" stock. At present, the minimum estimated fishery mortality and serious injury for this stock (30) appears to be less than 10% of the calculated PBR (77) and, therefore, appears to be insignificant and approaching zero mortality and serious injury rate. The stock size has increased in recent years, although at this time it is not possible to assess the status of the stock relative to its Optimum Sustainable Population (OSP) level.

REFERENCES

Angliss, R.P., D.P. DeMaster, and A.L. Lopez. 2001. Alaska marine mammal stock assessments, 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-124. 203 pp.

Bigg, M. A. 1969. The harbour seal in British Columbia. Fish. Res. Bd. Can. Bull. 172. 33 pp.

Bigg, M. A. 1981. Harbour seal, *Phoca vitulina*, Linnaeus, 1758 and *Phoca largha*, Pallas, 1811. Pp. 1-27, *In:* Ridgway, S. H., and R. J. Harrison (eds.), Handbook of Marine Mammals. Vol. 2: Seals. Academic Press, New York.

Boveng, P. 1988. Status of the Pacific harbor seal population on the U.S. west coast. Admin. Rep. LJ-88-06. Southwest Fisheries Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 43 pp.

Brown, R. F. 1988. Assessment of pinniped populations in Oregon. Processed Report 88-05, NMFS, Northwest and Alaska Fisheries Science Center, Seattle, WA.

Brown, R. F., and B. R. Mate. 1983. Abundance, movements, and feeding habits of the harbor seal, *Phoca vitulina*, at Netarts and Tillamook Bays, Oregon. Fish. Bull. 81:291-301.

Burg, T. M. 1996. Genetic analysis of eastern Pacific harbor seals (*Phoca vitulina richardsi*) from British Columbia and parts of Alaska using mitochondrial DNA and microsatellites. MS Thesis, Univ. of British Columbia, Vancouver, BC. 77 pp.

Calambokidis, J., S. Speich, J. Peard, G. Steiger, D. M. Fry, J. Lowenstine, and J. Cubbage. 1985. Biology of Puget Sound marine mammals and marine birds: population health and evidence of pollution effects. U.S. Dep. Commer., NOAA Tech. Memo. NOS-OMA-18. 159 pp.

Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Erstad, P., S. J. Jeffries, and D. J. Pierce. 1996. 1994 Report for the Puget Sound fishery observer program in management areas 10/11 & 12/12B: nontreaty chum gill net fishery. Final Report, Washington Dept. Fish and Wildlife, Olympia, WA. 14 pp.

Fisher, H. D. 1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. Fish. Res. Bd. Can. Bull. 93. 58 pp.

Gearin, P. J. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Gearin, P. J., S. R. Melin, R. L. DeLong, H. Kajimura, and M. A. Johnson. 1994. Harbor porpoise interactions with a chinook salmon set-net fishery in Washington State. Rep. Int. Whal. Commn. Special Issue 15:427-438.

Gearin, P. J., M. E. Gosho, J. L. Laake, L. Cooke, R. L. DeLong, and K. M. Hughes. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the state of Washington. J. Cetacean Res. Manage. 2(1):1-9.

Herder, M. J. 1986. Seasonal movements and hauling site fidelity of harbor seals, *Phoca vitulina richardsi,* tagged at the Russian River, California. MS Thesis, Humbolt State Univ., Humbolt, CA. 52 pp.

Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1994. Harbor seal, *Phoca vitulina richardsi*, stock assessment in Washington and Oregon, 1993. 1993 Annual Report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Huber, H. R., S. J. Jeffries, R. F. Brown, R. L. DeLong, and G. VanBlaricom. 2001. Correcting aerial survey counts of harbor seals (*Phoca vitulina richardsi*) in Washington and Oregon. Mar. Mammal. Sci. 17(2):276-293.

Jeffries, S. J. 1985. Occurrence and distribution patterns of marine mammals in the Columbia River and adjacent coastal waters of northern Oregon and Washington. *In*: Marine mammals and their interactions with fisheries of the Columbia River and adjacent waters, 1980-1982. Processed Report 85-04, NMFS, Northwest and Alaska Fisheries Center, Seattle, WA.

Jeffries, S. J., R. F. Brown, H. R. Huber, and R. L. DeLong. 1997. Assessment of harbor seals in Washington and Oregon, 1996. Pp. 83-94, *In:* Hill, P. S., and D. P. DeMaster (eds.), MMPA and ESA Implementation Program, 1996. AFSC Processed Report 97-10. 255 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Jeffries, S., H. Huber, J. Calambokidis, and J. Laake. In press. Trends and status of harbor seals in Washington State: 1978-1999. J. Wildl. Manage.

Lamont, M. M., J. T. Vida, J. T. Harvey, S. Jeffries, R. Brown, H. H. Huber, R. DeLong, and W. K. Thomas. 1996. Genetic substructure of the Pacific harbor seal (*Phoca vitulina richardsi*) off Washington, Oregon, and California. Mar. Mammal Sci. 12(3):402-413.

Melvin, E. F., L. L. Conquest, and J. K. Parrish. 1997. Seabird bycatch reduction: new tools for Puget Sound drift gillnet salmon fisheries. 1996 Sockeye and 1995 Chum Salmon Test Fisheries Final Report. Washington Sea Grant Program, Seattle, WA. 48pp.

Newby, T. C. 1973. Changes in Washington State harbor seal population, 1942-1972. Murrelet 54:5-6.

Northwest Indian Fisheries Commission (NWIFC). 1995. Monitoring of marbled murrelet and marine mammal interactions with 1994 tribal gillnet fisheries in northern Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Final Report to NMFS, Contract No. 52ABNF400087, and USFWS. Unpubl. report. 41 pp. Available

at NWIFC, 6730 Martin Way E, Olympia, WA 98516.
Pierce, D. J., W. P. Ritchie, and R. Kreuziger. 1994. Preliminary findings of seabird interactions with the non-treaty salmon gill net fishery: Puget Sound and Hood Canal Washington. Unpubl. report. Washington Dept. Fish and Wildlife, Olympia, WA. 39 pp. Available at WDFW, 600 Capitol Way N, Olympia, WA 98501.
Pierce, D. J., M. Alexandersdottir, S. J. Jeffries, P. Erstad, W. Beattie, and A. Chapman. 1996. Interactions of marbled murrelets and marine mammals with the 1994 Puget Sound sockeye gill net fishery. Final Report, Washington Dept. Fish and Wildlife, Olympia, WA. 21 pp.
Pitcher, K. W., and D. G. Calkins. 1979. Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 19(1983):231-310.
Pitcher, K. W., and D. C. McAllister. 1981. Movements and haul out behavior of radio-tagged harbor seals, *Phoca vitulina*. Can. Field Nat. 95:292-297.
Scheffer, V. B., and J. W. Slipp. 1944. The harbor seal in Washington State. Amer. Midl. Nat. 32:373-416.
Scordino, J. National Marine Fisheries Service, Northwest Region, 7600 Sand Point Way NE, Seattle, WA 98115.
Temte, J. L. 1986. Photoperiod and the timing of pupping in the Pacific harbor seal (*Phoca vitulina richardsi*) with notes on reproduction in northern fur seals and Dall's porpoises. MS Thesis, Oregon State Univ., Corvallis, OR.
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.

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NORTHERN ELEPHANT SEAL (*Mirounga angustirostris*): California Breeding Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern elephant seals breed and give birth in California (U.S.) and Baja California (Mexico), primarily on offshore islands (Stewart et al. 1994), from December to March (Stewart and Huber 1993). Males feed near the eastern Aleutian Islands and in the Gulf of Alaska, and females feed further south, south of 45°N (Stewart and Huber 1993; Le Boeuf et al. 1993). Adults return to land between March and August to molt, with males returning later than females. Adults return to their feeding areas again between their spring/summer molting and their winter breeding seasons.

Populations of northern elephant seals in the U.S. and Mexico were all originally derived from a few tens or a few hundreds of individuals surviving in Mexico after being nearly hunted to extinction (Stewart et al. 1994). Given the very recent derivation of most rookeries, no genetic differentiation would be expected. Although movement and genetic exchange continues between rookeries, most elephant seals return to their natal rookeries when they start breeding (Huber et al. 1991). The California breeding population is now demographically isolated from the Baja California population. No international agreements exist for the joint management of this species by the U.S. and Mexico. The California breeding population is considered here to be a separate stock.

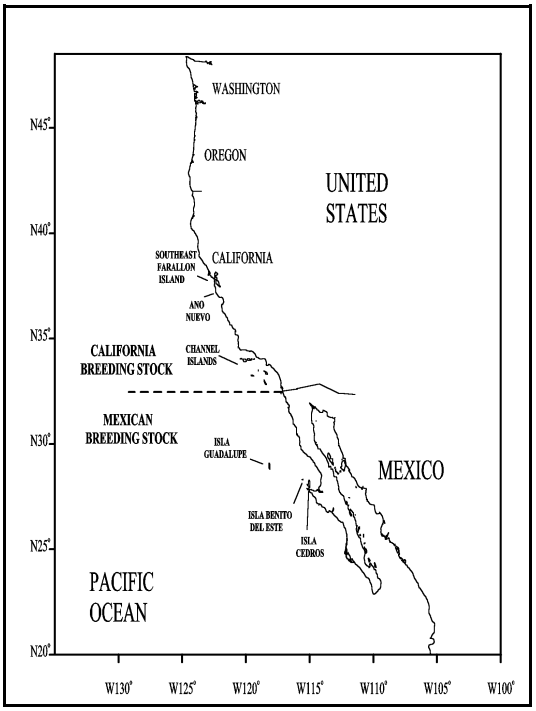

Figure 3. Stock boundary and major rookery areas for northern elephant seals in the U.S. and Mexico.

POPULATION SIZE

A complete population count of elephant seals is not possible because all age classes are not ashore at the same time. Elephant seal population size is typically estimated by counting the number of pups produced and multiplying by the inverse of the expected ratio of pups to total animals (McCann 1985). Stewart et al. (1994) used McCann's multiplier of 4.5 to extrapolate from 28,164 pups to a population estimate of 127,000 elephant seals in the U.S. and Mexico in 1991. The multiplier of 4.5 was based on a non-growing population. Boveng (1988) and Barlow et al.(1993) argue that a multiplier of 3.5 is more appropriate for a rapidly growing population such as the California stock of elephant seals. Based on the estimated 28,845 pups born in California in 2001 (Fig. 2) and this 3.5 multiplier, the California stock was approximately 101,000 in 2001.

Minimum Population Estimate

The minimum population size for northern elephant seals can be estimated very conservatively as 60,547, which is equal to twice the observed pup count (to account for the pups and their mothers) plus 2,317 males and 17 juveniles counted at the Channel Island sites in 2001 (Mark Lowry, NMFS unpubl. data) and 523 males counted at Año Nuevo sites in 1996 (Le Boeuf 1996). More sophisticated methods of estimating minimum population size could be applied if the variance of the multiplier used to estimate population size were known.

Current Population Trend

Based on trends in pup counts, northern elephant seal colonies were continuing to grow in California through

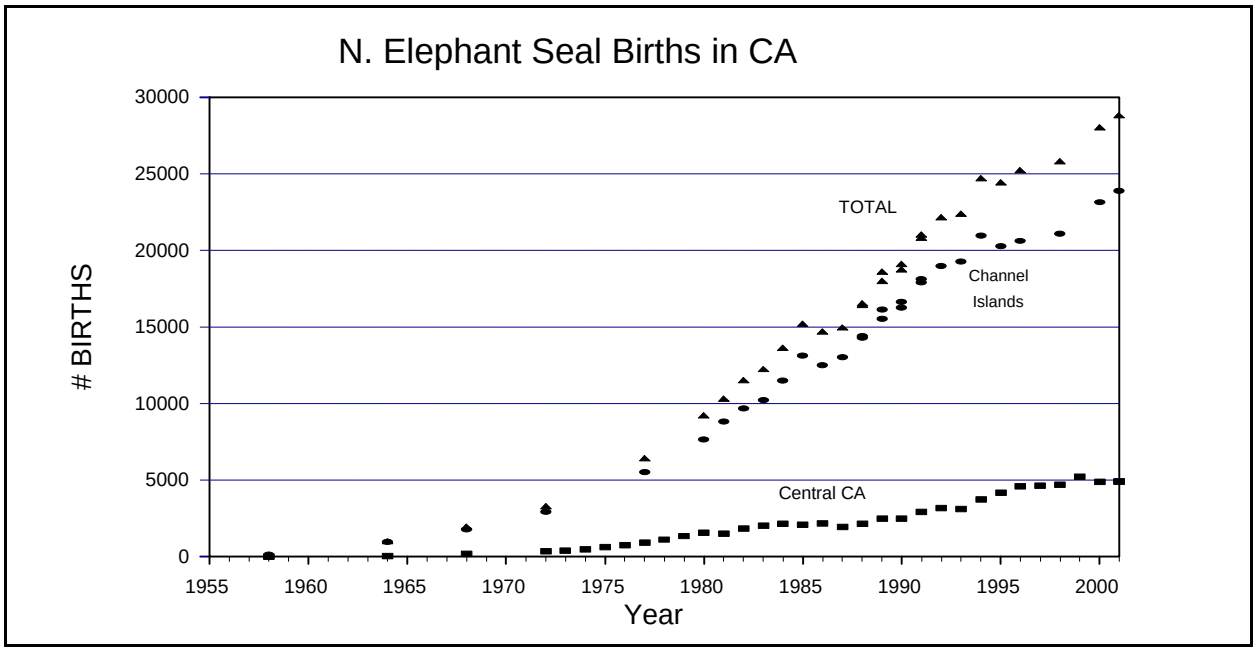

Figure 2. Estimated number of northern elephant seal births in California 1958-2001. Multiple independent estimates are presented for the Channel Islands 1988-91. Estimates are from Stewart et al. (1994), Lowry et al. (1996), and unpublished data from Sarah Allen, Dan Crocker, Brian Hatfield, Ron Jameson, Bernie Le Boeuf, Mark Lowry, Pat Morris, Guy Oliver, and William Sydeman.

2001 (Fig. 2) but appear to be stable or slowly decreasing in Mexico (Stewart et al. 1994).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Although growth rates as high as 16% per year have been documented for elephant seal rookeries in the U.S. from 1959 to 1981 (Cooper and Stewart 1983), much of this growth was supported by immigration from Mexico. The highest growth rate measured for the whole U.S./Mexico population was 8.3% between 1965 and 1977 (Cooper and Stewart 1983). A continuous growth rate of 8.3% is consistent with an increase from approximately 100 animals in 1900 to the current population size. The "maximum estimated net productivity rate" as defined in the Marine

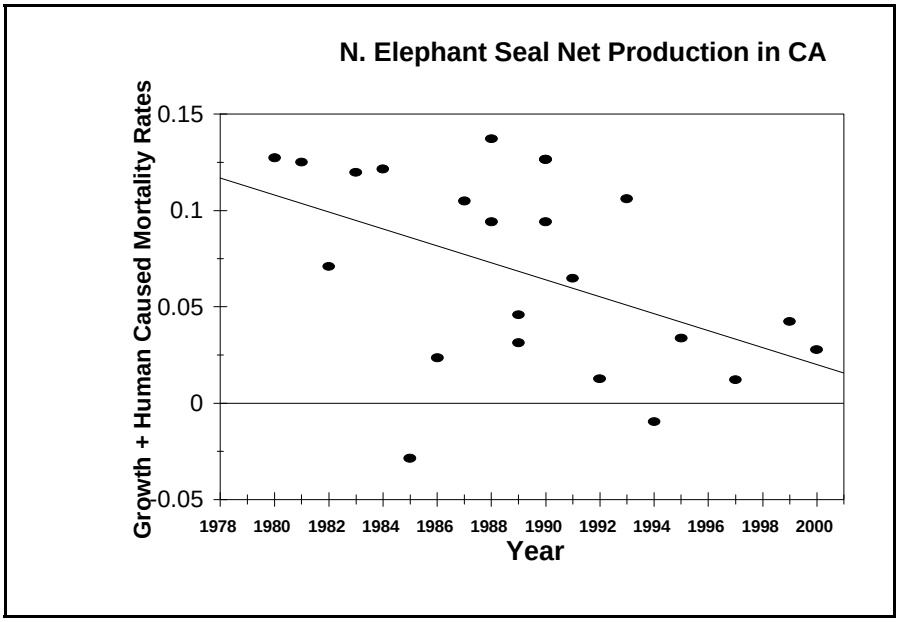

Figure 3. Net production rates for northern elephant seals in California based on pup births and fishery mortality. Annual mortality for 1980-1987 is assumed to be 300, the average of 1988-90 values (Perkins et al. 1994).

Mammal Protection Act (MMPA) would therefore be 8.3%. In California, the net productivity rate appears to have declined in recent years [Figure 3; net production rate was calculated as the realized rate of population growth (increase in pup abundance from year *i* to year *i+1*, divided by pup abundance in year *i*) plus the harvest rate (fishery mortality in year *i* divided by population size in year *i*)].

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (60,547) times one half the observed maximum net growth rate for this stock (½ of 8.3%) times a recovery factor of 1.0 (for a stock of unknown status that is increasing, Wade and Angliss 1997) resulting in a PBR of 2,513.

Table 1. Summary of available information on the mortality and serious injury of northern elephant seals (California breeding stock) in commercial fisheries that might take this species (Julian 1997; Cameron and Forney 1999, 2000; Carretta 2001; Perez, in prep.; NMFS unpubl. data). n/a indicates information is not available. Mean annual takes are based on 1996-2000 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1996 1997 1998 1999 2000	observer data	12.4% 22.8% 20.2% 20.0% 25.1%	4 8 4 1 6	37 (0.55) 45 (0.33) 20 (0.44) 10 (0.61) 26 (0.41)	25 (0.21) [1]
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	1996 1997 1998 1999 2000	observer data extrapo-lated estimate	0.0% 0.0% 0.0% 23.1% [3] 26.9% [3]	- - - 10 † 4 †	46 (0.23) [2] 60 (0.24) [2] 70 (0.26) [2] 76 (0.19) [2] 48 (0.23) [2]	60 (0.10)
WA, OR, CA groundfish trawl	1998	observer data	77%	1	1 (n/a)	1 (n/a)
WA Willapa Bay drift gillnet fishery (salmon)	1991	personal communication	n/a	2	2	n/a
Chehalis River salmon setnet fishery	1993	personal communication	n/a	4	4	n/a
Total annual takes						> 86 (0.14)

[1] Only 1997-2000 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). Following these changes in the fishery, entanglement rates of northern elephant seals declined.

[2] The CA set gillnets were not observed in 1995-98, and observations in 1999-2000 only included Monterey Bay; mortality for unobserved areas and times was extrapolated from effort estimates and 1991-94 entanglement rates.

† Observer coverage and observed mortality in 1999-2000 only includes the portion of the fishery in Monterey Bay.

HUMAN-CAUSED MORTALITY

Fisheries Information

A summary of known fishery mortality and injury for this stock of northern elephant seals is given in Table 1. More detailed information on these fisheries is provided in Appendix 1. The set gillnet fishery in Monterey was observed again in 1999-2000 after a lapse of four years. Entanglement rates of northern elephant seals were similar to extrapolated rates in the previous three years; therefore, mortality estimates for the five most recent years were averaged to give the mean annual take for that fishery. Current mortality could not be estimated for a few fisheries that have taken

small numbers of elephant seals in the past; therefore, the overall mortality is likely to be slightly greater than 86 per year. Stranding data reported to the California Marine Mammal Stranding Network in 1996-2000 include elephant seal injuries caused by hook-and-line fisheries (2 injuries) and gillnet fisheries (1 injury).

Although all of the mortalities in Table 1 occurred in U.S. waters, some may be of seals from Mexico's breeding population that are migrating through U.S. waters. Similar drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably take northern elephant seal. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which has increased from two vessels in 1986 to 29 vessels in 1992 (Sosa-Nishizaki et al. 1993). 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), 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 (David Holts, NMFS, SWFSC, pers. comm.). The number of set-gillnet vessels in this part of Mexico is unknown. The take of northern elephant seals in other North Pacific fisheries that have been monitored appears to be trivial (Barlow et al. 1993, 1994).

Other Mortality

The California Marine Mammal Stranding database maintained by the National Marine Fisheries Service, Southwest Region, contains the following records of human-related elephant seal mortalities and injuries in 1996-2000: (1) boat collision (2 mortalities, 1 injury), (2) automobile collision (5 mortalities), (3) shootings (3 mortalities) and (4) entanglement in marine debris (1 injury). Protective measures were taken to prevent future automobile collisions in the vicinity of Piedras Blancas/San Simeon (Hatfield and Rathbun 1999).

STATUS OF STOCK

A review of elephant seal dynamics through 1991 concluded that their status could not be determined with certainty, but that they might be within their Optimal Sustainable Population (OSP) range (Barlow et al. 1993). They are not listed as "endangered" or "threatened" under the Endangered Species Act nor as "depleted" under the MMPA. Because their annual human-caused mortality is much less than the calculated PBR for this stock (2,513), they would not be considered a "strategic" stock under the MMPA. The average rate of incidental fishery mortality for this stock over the last 5 years (86) also appears to be less than 10% of the calculated PBR; therefore, the total fishery mortality appears to be insignificant and approaching a zero mortality and serious injury rate. The population is continuing to grow and fishery mortality is relatively constant. There are no known habitat issues that are of particular concern for this stock.

REFERENCES

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., P. Boveng, M. S. Lowry, B. S. Stewart, B. J. Le Boeuf, W. J. Sydeman, R. J. Jameson, S. G. Allen, and C. W. Oliver. 1993. Status of the northern elephant seal population along the U.S. west coast in 1992. Admin. Rept. LJ-93-01. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 32 pp.

Boveng, P. 1988. Status of the northern elephant seal population on the U.S. West Coast. Admin. Rep. LJ-88-05 Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 35pp.

Cameron, G. A., and K. A. Forney. 2000. Preliminary estimates of cetacean mortality in California/Oregon gillnet fisheries for 1999. Paper SC/52/O24 presented to the International Whaling Commission (unpublished). 12 pp.

Carretta, J.V. 2001. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2000. Paper SC/53/SM9 presented to the International Whaling Commission (unpublished). 21 pp.

Cooper, C. F. and B. S. Stewart. 1983. Demography of northern elephant seals, 1911-1982. Science 219:969-971.

Hatfield, B. B., and G. B. Rathbun. 1999. Interactions between northern elephant seals and vehicles near Point Piedras

Blancas, California. Mar. Mamm. Sci. 15(2):598-600.

Huber, H. R., A. C. Rovetta, L. A. Fry, and S. Johnston. 1991. Age-specific natality of northern elephant seals at the South Farallon Islands, California. J. Mamm. 72(3):525-534.

Julian, F. 1997. Cetacean mortality in California gillnet fisheries: preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission (unpublished). 13pp.

Le Boeuf, B. J. 1996. Northern elephant seals at Año Nuevo during the breeding seasons of 1992-1996. Admin. Rep. LJ-96-12C. Southwest Fisheries Science Center, National Marine Fisheries Service, P. O. Box 271, La Jolla, California, 92038. 8 pp.

Le Boeuf, B. J., D. Crocker, S. Blackwell, and P. Morris. 1993. Sex differences in diving and foraging behaviour of northern elephant seals. In: I. Boyd (ed.). Marine Mammal: Advances in Behavioural and Population Biology. Oxford Univ. Press.

Lowry, M. S., W. L. Perryman, M. S. Lynn, R. L. Westlake, and F. Julian. 1996. Counts of northern elephant seals, Mirounga angustirostris, from large-format aerial photographs taken at rookeries in southern California during the breeding season. Fish. Bull. 94:176-185.

McCann, T. S. 1985. Size, status and demography of southern elephant seal (Mirounga leonina) populations. In J. K. Ling and M. M. Bryden (eds.), Studies of Sea Mammals in South Latitudes. South Australian Museum. 132 pp.

Perez, M. A. (In prep.). Summary of marine mammal incidental catch data for domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-96.

Perkins, P., J. Barlow, and M. Beeson. 1994. Report on pinniped and cetacean mortality in California gillnet fisheries: 1988-90. Admin. Rep. LJ-94-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P. O. Box 271, La Jolla, California, 92038. 16 pp.

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.

Stewart, B. S., and H. R. Huber. 1993. Mirounga angustirostris. Mammalian Species 449:1-10.

Stewart, B. S., B. J. Le Boeuf, P. K. Yochem, H. R. Huber, R. L. DeLong, R. J. Jameson, W. Sydeman, and S. G. Allen. 1994. History and present status of the northern elephant seal population. In: B. J. Le Boeuf and R. M. Laws (eds.) Elephant Seals. Univ. Calif. Press, Los Angeles.

Wade P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12 available from Office of Protected Resources, National Marine Fisheries Service, Silver Springs, MD. 93pp..

Revised 12/15/2000

GUADALUPE FUR SEAL (*Arctocephalus townsendi*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

Commercial sealing during the 19th century reduced the once abundant Guadalupe fur seal to near extinction in 1894 (Townsend 1931). Prior to the harvest it ranged from Monterey Bay, California, to the Revillagigedo Islands, Mexico (Fleischer 1987, Hanni et al. 1997; Figure 1). The capture of two adult males at Guadalupe Island in 1928 established the species' return (Townsend 1931); however, they were not seen again until 1954 (Hubbs 1956). Guadalupe fur seals pup and breed mainly at Isla Guadalupe, Mexico. In 1997, a second rookery was discovered at Isla Benito del Este, Baja California (Maravilla-Chavez and Lowry 1999) and a pup was born at San Miguel Island, California (Melin and DeLong 1999). Individuals have stranded or been sighted as far north as Blind Beach, California (38° 26' 10" N, 123° 07' 20" W); inside the Gulf of California and as far south as Zihuatanejo, Mexico (17° 39' N, 101° 34'W; Hanni et al. 1997 and Aurioles-Gamboa and Hernadez-Camacho 1999). The population is considered to be a single stock because all are recent descendants from one breeding colony at Isla Guadalupe, Mexico.

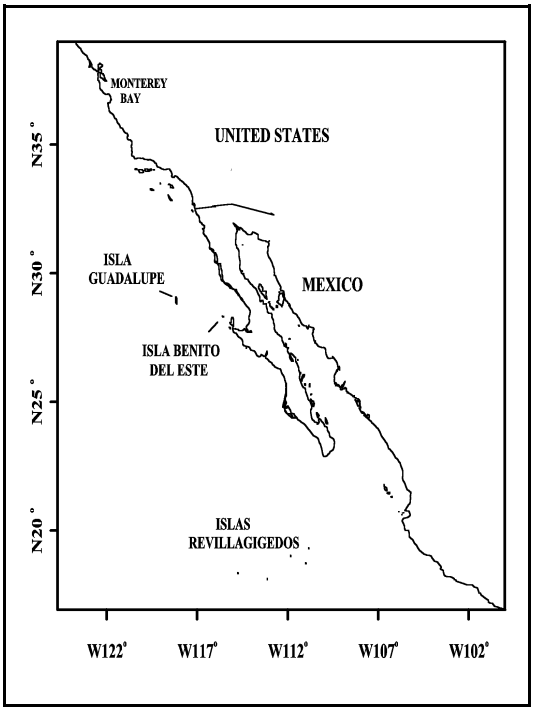

Figure 1. Geographic range of the Guadalupe fur seal, showing location of two rookeries at Isla Guadalupe and Isla Benito Del Este.

POPULATION SIZE

The size of the population prior to the commercial harvests of the 19th century is not known, but estimates range from 20,000 to 100,000 animals (Wedgeforth 1928, Hubbs 1956, Fleischer 1987). The population was estimated by Gallo (1994) to be about 7,408 animals in 1993. The population estimate was derived by multiplying the number of pups (counted and estimated) by a factor of 4.0.

Minimum Population Estimate

All the individuals of the population cannot be counted because all age and sex classes are never ashore at the same time and some individuals that are on land are not visible during the census. Sub-sampling portions of the rookery indicate that only 47-55% of the seals present (i.e., hauled out) are counted during the census (Gallo 1994). The 1993 count of all age classes plus the estimate of missed animals was 6,443 (Gallo 1994). The minimum size of the population in Mexico can be estimated as the actual count of 3,028 hauled out seals [The actual count data were not reported by Gallo (1994); this number is derived by multiplying the estimated number hauled out by 47%, the minimum estimate of the percent counted]. In the United States, a few Guadalupe fur seals are known to inhabit California sea lion rookeries in the Channel Islands (Stewart et al. 1987).

Current Population Trend

Counts of Guadalupe fur seals have been made sporadically since 1954. Records of Guadalupe fur seal counts through 1984 were compiled by Seagars (1984), Fleischer (1987), and Gallo (1994). The count for 1988 was taken from Torres et al. (1990). A few of these counts were made during the breeding season, but the majority were made at other times of the year (Figure 1). Also, the counts that are documented in the literature generally provide only the total of all Guadalupe fur seals counted (i.e., the counts are not separated by age/sex class). The counts that were made during the breeding season, when the maximum number of animals are present at the rookery, were used to examine population growth (Gallo 1994). The natural logarithm of the counts was regressed against year to calculate the growth rate of the population. These data indicate that the population of Guadalupe fur seals is increasing exponentially at an average annual growth rate of 13.7% (Gallo 1994; Figure 2).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The maximum net productivity rate can be assumed to be equal to the annual growth rate observed over the last 30 years (13.7%) because the population was at a very low level and should have been growing at nearly its maximum rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) for this stock is calculated as the minimum population size (3,028) times one half the default maximum net growth rate for pinnipeds (½ of 12%) times a recovery factor of 0.5 (for a threatened species, Wade and Angliss 1997), resulting in a PBR of 104 Guadalupe fur seals per year. The vast majority of this PBR would apply towards incidental mortality in Mexico.

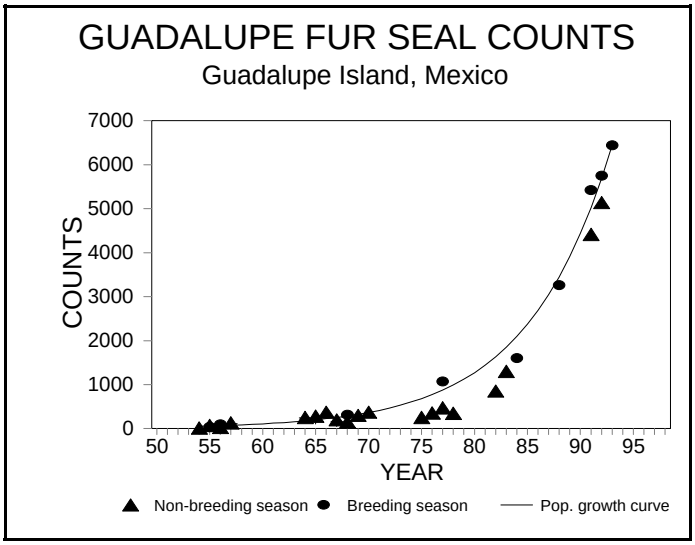

Figure 2. Counts of Guadalupe fur seals at Guadalupe Island, Mexico, and the estimated population growth curve derived from counts made during the breeding season.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Drift and set gillnet fisheries may cause incidental mortality of Guadalupe fur seals in Mexico and the United States. In the United States there have been no reports of mortalities or injuries for Guadalupe fur seals (Barlow et al.1994, Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999. No information is available for human-caused mortalities or injuries in Mexico. However, similar drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery (Sosa-Nishizaki et al. 1993). 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 1990-93 (0.15 marine mammals per set), 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.). The number of set gillnets used in Mexico is unknown.

Other mortality

Juvenile female Guadalupe fur seals have stranded in central and northern California with net abrasions around the neck, fish hooks and monofilament line, and polyfilament string (Hanni et al. 1997).

STATUS OF STOCK

The state of California lists the Guadalupe fur seal as a fully protected mammal in the Fish and Game Code of California (Chap. 8, sec. 4700, d), and it is listed also as a threatened species in the Fish and Game Commission California Code of Regulations (Title 14, sec. 670.5, b, 6, H). The Endangered Species Act lists it as a threatened species, which automatically qualifies this as a "depleted" and "strategic" stock under the Marine Mammal Protection Act. There is insufficient information to determine whether the fishery mortality in Mexico exceeds the PBR for this stock. The total U.S. fishery mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The population is growing at approximately 13.7% per year.

Table 1. Summary of available information on the incidental mortality and injury of Guadalupe fur seals in commercial fisheries that might take this species (Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999, M. Perez per. comm, Appendix 1). Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA driftnet fishery for sharks and swordfish	1994 1995 1996 1997 1998	observer	17.9% 15.6% 12.4% 22.8% 20.2%	0 0 0 0 0	0 0 0 0 0	0[1]
CA set gillnet fishery for halibut and angel shark	1994 1995 1996 1997 1998	observer extrapolated estimates (1995-98)	7.7% 0% 0% 0% 0%	0 0 0 0 0	0 0[2] 0[2] 0[2] 0[2]	0[2]
WA, OR, CA ground fish trawl fishery (At-sea processing Pacific whiting fishery only)	1994 1995 1996 1997 1998	observer	53.8% 56.2% 65.2% 65.7% 77.3%	0 0 0 0 0	0 0 0 0 0	0
Minimum total annual takes						0

[1] Only 1997-98 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).

[2] The CA set gillnets were not observed after 1994; mortality was extrapolated from effort estimates and previous entanglement rates.

REFERENCES

Aurioles-Gamboa, D. and C. J. Hernadez-Camacho. 1999. Notes on the southernmost records of Guadalupe fur seal, Arctocephalus townsendi, in Mexico. Mar. Mamm. Sci. 15:581-583.

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 USA and Canada and the east coast of the Russian Federation. Rept. Int. Whaling Comm., Special Issue 15:405-425.

Cameron, G., and K. A. Forney. 1999. 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.

Fleischer, L. A. 1987. Guadalupe fur seal, *Arctocephalus townsendi*. In J. P. Croxall and R. L. Gentry (eds.). Status, biology, and ecology of fur seals. Proceedings of an international symposium and workshop. Cambridge, England, 23-27 April 1984. p. 43-48. U.S. Dept. of Commerce, NOAA, NMFS, NOAA Tech. Rept. NMFS 51.

Gallo, J. P. 1994. Factors affecting the population status of Guadalupe fur seal, *Arctocephalus townsendi* (Merriam, 1897), at Isla de Guadalupe, Baja California, Mexico. Ph.D. Thesis, University of California, Santa Cruz, 199 p.

Hanni, K. D., D. J. Long, R. E. Jones, P. Pyle, and L. E. Morgan. 1997. Sightings and strandings of Guadalupe fur seals in central and northern California, 1988-1995. J. of Mamm. 78:684-690.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

Hubbs. C. L. 1956. The Guadalupe fur seal still lives! Zoonooz, S. D. Zool. Soc. 29(12):6-9.

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 for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fish. Bull. 96:271-284.

Maravilla-Chavez, M. O. and M. S Lowry. 1999 Incipient breeding colony of Guadalupe fur seals at Isla Benito del

Este, Baja California, Mexico. Mar. Mamm. Sci. 15:239-241.
Melin, S. R. and R. L. DeLong. 1999. Observations of a Guadalupe fur seal (Arctocephalus townsendi) female and pup at San Miguel Island, California. Mar. Mamm. Sci. 15:885-888.
Perkins, P., J. Barlow, and M. Beeson. 1992. Pinniped and cetacean mortality in California gillnet fisheries: 1991. Rept. Int. Whaling Commission, Working Paper SC/44/SM14.
Seagars, D. J. 1984. The Guadalupe fur seal: a status review. National Marine Fisheries Service, Southwest Region, Admin. Rep. SWR-84-6. 29pp.
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.
Stewart, B. S., P. K. Yochem, R. L. DeLong, and G.A. Antonelis Jr. 1987. Interactions between Guadalupe fur seals and California sea lions ant San Nicolas and San Miguel islands, California. In J. P. Croxall and R. L. Gentry (eds.). Status, biology, and ecology of fur seals. Proceedings of an international symposium and workshop. Cambridge, England, 23-27 April 1984. p. 103-106. U.S. Dept. of Commerce, NOAA, NMFS, NOAA Tech. Rept. NMFS 51.
Torres-G., A., A. Aguayo-L., and N. Valdez-T. 1990. Tamaño y distribucion de la poblacion del lobo fino de Guadalupe, *Arctocephalus townsendi* (Merriam, 1897), durante el verano de 1988. [Abstracts] XV Reunion internacional para el estudio de los mamiferos marinos, 18-20 April 1990. La Paz, B. C. S., Mexico.
Townsend, C. H. 1931. The fur seal of the California islands with new descriptive and historical matter. Zoologica 9:443-457.
Wedgeforth, H. M. 1928. The Guadalupe fur seal (*Arctocephalus townsendi*). Zoonooz, S. D. Zool. Soc. 3(3):4-9.

Revised 12/15/2000

NORTHERN FUR SEAL (*Callorhinus ursinus*): San Miguel Island Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern fur seals occur from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan (Fig. 1). During the breeding season, approximately 74% of the worldwide population is found on the Pribilof Islands in the southern Bering Sea, with the remaining animals spread throughout the North Pacific Ocean (Lander and Kajimura 1982). Of the seals in U.S. waters outside of the Pribilofs, approximately 1% of the population is found on Bogoslof Island in the southern Bering Sea and San Miguel Island off southern California (NMFS 1993). Northern fur seals may temporarily haul out on land at other sites in Alaska, British Columbia, and on islets along the coast of the continental United States, but generally outside of the breeding season (Fiscus 1983).

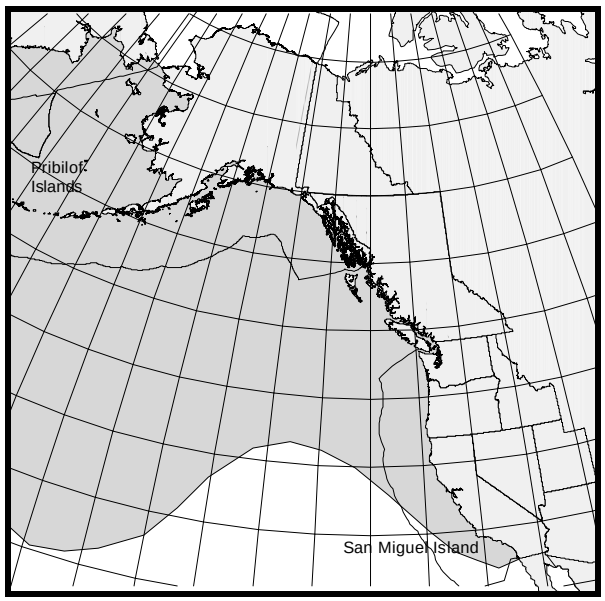

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

Due to differing requirements during the annual reproductive season adult males and females typically occur ashore at different, though overlapping times. Adult males usually occur on shore during the 4-month period from May-August, though some may be present until November (well after giving up their territories). Adult females are found ashore for as long as six months (June-November). After their respective times ashore, seals of both genders spend the next 7-8 months at sea (Roppel 1984). Adult females and pups from the Pribilof Islands migrate through the Aleutian Islands into the North Pacific Ocean, often to the Oregon and California offshore waters. Many pups may remain at sea for 22 months before returning to their rookery of birth. Adult males from the Pribilof Islands generally migrate only as far south as the Gulf of Alaska (Kajimura 1984). There is considerable interchange of individuals between rookeries.

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: (1) Distributional data: geographic distribution is continuous during feeding, geographic separation during the breeding season, high natal site fidelity (DeLong 1982); (2) Population response data: substantial differences in population dynamics between Pribilofs and San Miguel Island (DeLong 1982, DeLong and Antonelis 1991, NMFS 1993); (3) Phenotypic data: unknown; and (4) Genotypic data: unknown. Based on this information, two separate stocks of northern fur seals are recognized within U.S. waters: an Eastern Pacific stock and a San Miguel Island stock. The Eastern Pacific stock is reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

The population estimate for the San Miguel Island stock of northern fur seals is calculated as the estimated number of pups at rookeries multiplied by an expansion factor. Based on research conducted on the Eastern Pacific stock of northern fur seals, a life table analysis was performed to estimate the number of yearlings, 2 year olds, 3 year olds, and animals at least 4 years old (Lander 1981). The resulting population estimate was equal to the pup count multiplied by 4.475. The expansion factors are based on a sex and age distribution estimated after the harvest of juvenile males was terminated. A more appropriate expansion factor for the San Miguel Island stock is 4.0, based on the known increased immigration of recruitment-age females (DeLong 1982) and mortality and possible emigration of adults associated with the El Niño Southern Oscillation event in 1982-1983 (R. DeLong, pers. comm.). A 1998 pup count resulted in a total count of 627 pups, a 79.6% decrease from the 1997 count of 3,068 (Melin and DeLong 2000). In 1999, the population began to recover with a total pup count of 1,084 (S. Melin, unpubl. data). Based on the 1999 count and the expansion factor, the most recent population estimate of the San Miguel Island stock is 4,336 (1,084 x

4.0) northern fur seals. Currently, a CV for the expansion factor is unavailable.

Minimum Population Estimate

The survey technique utilized for estimating the abundance of northern fur seals within the San Miguel Island stock is a direct count, with no associated CV(N) as sites are surveyed only once. Additional estimates of the overall population size (i.e., N_{BEST}) and associated CV are also unavailable. Therefore N_{MIN} for this stock can not be estimated by calculating the log-normal 20th percentile of the population estimate. Rather, N_{MIN} is estimated as twice the maximum number of pups born in 1999 (to account for the pups and their mothers) plus the maximum number of adult and sub-adult males counted for the 1999 season, which results in an N_{MIN} of 2,336 ((1,084 x 2) + 168). This method provides a very conservative estimate of the northern fur seal population at San Miguel Island.

Current Population Trend

The population of northern fur seals on San Miguel Island originated from the Pribilof Islands population during the late 1950s or early 1960s (DeLong 1982). The colony has increased steadily, since its discovery in 1968, except for severe declines in 1983 and 1998 associated with El Niño Southern Oscillation events in 1982-1983 and 1997-1998 (DeLong and Antonelis 1991, Melin and DeLong 2000). El Niño events, which occur periodically along the California coast, impact population growth of fur seals at San Miguel Island and are an important regulatory mechanism for this population (DeLong and Antonelis 1991; Melin and DeLong 1994, 2000; Melin et al. 1996).

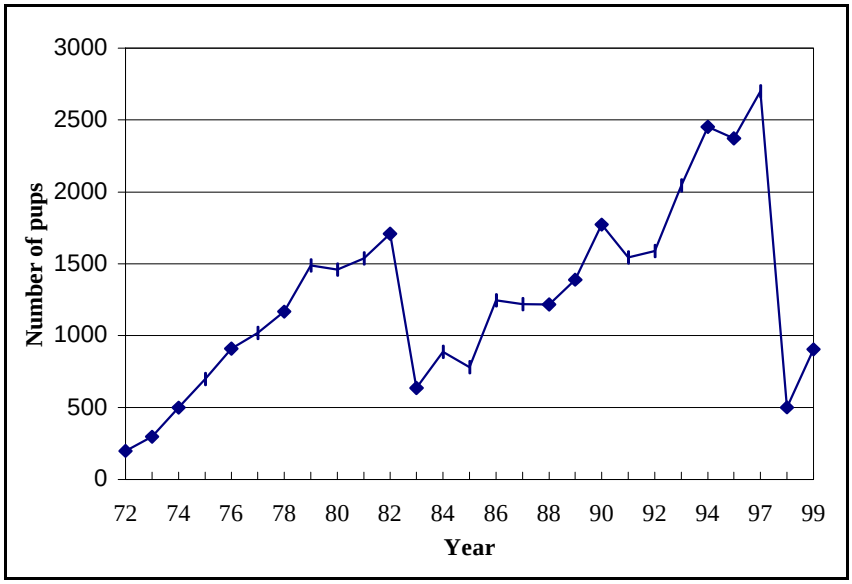

Figure 2. Northern fur seal live pup counts on San Miguel Island, 1972-1999. Counts from 1996 were incomplete and have not been included in the figure.

Specifically, live pup counts increased about 24% annually from 1972 through 1982, an increase due, in part, to immigration of females from the Bering Sea and the western North Pacific Ocean (DeLong 1982) (Fig. 2). The 1982-1983 El Niño event resulted in a 60.3% decline in the northern fur seal population at San Miguel Island (DeLong and Antonelis 1991). It took the population 7 years to recover from this decline, because adult female mortality occurred in addition to pup mortality (Melin and DeLong 1994). The 1992-1993 El Niño conditions resulted in reduced pup production in 1992, but the population recovered in 1993 and increased in 1994 (Melin et al. 1996).

From July 1997 through May 1998, the most severe El Niño event in recorded history affected California coastal waters (Lynn et al. 1998). In 1997, total fur seal pup production was 3,068 pups, the highest recorded since the colony has been monitored. However, it appears that up to 87% of the pups born in 1997 died before weaning, and total production in 1998 was only 627 pups, a decline of 79.6% from 1997 (Melin and DeLong 2000). Although total production increased to 1,084 in 1999 (S. Melin, unpubl. data), a slow recovery from the 1998 decline is anticipated if adult female mortality occurred in addition to the high pup mortality in 1997 and 1998 (Melin and DeLong 2000).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The northern fur seal population in the Pribilof Islands increased steadily during 1912-1924 after the commercial harvest no longer included pregnant females. During this period, the rate of population growth was approximately 8.6% (SE=1.47) per year (A. York, unpubl. data), the maximum recorded for this species. This growth

rate is similar and slightly higher than the 8.12% rate of increase (approximate SE=1.29) estimated by Gerrodette et al. (1985). Given the extremely low density of the population in the early 1900s, the 8.6% rate of increase is considered a reliable estimate of R_{MAX}.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population estimate (2,336) times one-half the observed maximum net growth rate (½ of 8.6%) times a recovery factor of 1.0 (for stocks of unknown status that are increasing in size, Wade and Angliss 1997), resulting in a PBR of 100 San Miguel Island northern fur seals per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Northern fur seals taken during the winter/spring along the west coast of the continental U.S. could be from the Pribilofs and thus belong to the Eastern Pacific stock. However, it is the intention of NMFS to consider any takes of northern fur seals by commercial fisheries in waters off California, Oregon, and Washington as being from the San Miguel Island stock. Information concerning the three observed fisheries that may have interacted with northern fur seals are listed in Table 1. There were no reported mortalities of northern fur seals in any observed fishery along the west coast of the continental U.S. during the period from 1994-1998 (Table 1; Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999). Overall entanglement rates in the California/Oregon thresher shark/swordfish drift gillnet fishery dropped considerably 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 (Barlow and Cameron 1999). Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-1998 data. Fishing effort in the California angel shark/halibut set gillnet fishery was substantially reduced as a result of a California voter proposition banning gillnet fishing in certain areas (Julian 1997, Julian and Beeson 1998). For this fishery, there were no observed sets after 1994. The estimated mean mortality rate in observed fisheries is zero northern fur seals per year from this stock.

An additional source of information on the number of northern fur seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1994 and 1998, there were no fisher self-reports of northern fur seal mortalities from any fisheries operating within the range of this stock. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 4 of Hill and DeMaster 1998).

Table 1. Summary of available information on the incidental mortality and injury of northern fur seals (San Miguel Island stock) in commercial fisheries that might take this species and calculation of the mean annual mortality rate; n/a indicates that data are not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
CA/OR thresher shark/ swordfish drift gillnet	94	obs data	17.9%	0	0	0[1]
	95		15.6%	0	0	
	96		12.4%	0	0	
	97		23.0%	0	0	
	98		20.0%	0	0	
CA angel shark/halibut set gillnet	94	obs data	7.7%	0	0	0
	95	extrapolated	0%	0	0[2]	0
	96	estimates	0%	0	0[2]	
	97	(1995-98)	0%	0	0[2]	
	98		0%	0	0[2]	

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
WA/OR/CA groundfish trawl (Pacific whiting component)	94 95 96 97 98	obs data	53.8% 56.2% 65.2% 65.7% 77.3%	0 0 0 0 0	0 0 0 0 0	0
CA/OR thresher shark/ swordfish drift gillnet	94-98	self reports	n/a	n/a, n/a, n/a, n/a, n/a	n/a	-
CA angel shark/halibut set gillnet	94-98	self reports	n/a	n/a, n/a, n/a, n/a, n/a	n/a	-
unknown west coast fishery	94-98	strand data	n/a	0, 0, 0, 0, 0	n/a	0
Minimum total annual takes						0

[1] Only 1997-98 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).

[2] The California set gillnets were not observed after 1994; mortality was extrapolated from effort and previous entanglement rates.

Strandings of northern fur seals entangled in fishing gear or with injuries caused by interactions with gear are a final source of fishery-related mortality information. During 1994-1998, no northern fur seal strandings occurred. Fishery-related strandings during 1994-1998 resulted in an estimated annual mortality of zero animals from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

STATUS OF STOCK

The San Miguel Island northern fur seal stock is not considered to be "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the estimated annual level of total human-caused mortality and serious injury (0) does not exceed the PBR (100). Therefore, the San Miguel Island stock of northern fur seals is not classified as a strategic stock. The minimum total fishery mortality and serious injury for this stock (0) is not known to exceed 10% of the calculated PBR (10) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The stock size decreased 79.6% from 1997 to 1998 and began to recover in 1999. The status of this stock relative to its Optimum Sustainable Population (OSP) level is unknown, unlike the Eastern Pacific northern fur seal stock which is formally listed as "depleted" under the MMPA.

REFERENCES

Barlow, J., and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20 pp.

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.

DeLong, R. L. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA, 98115.

DeLong, R. L. 1982. Population biology of northern fur seals at San Miguel Island, California. Ph.D. Thesis, University of California, Berkeley, California. 185 pp.

DeLong, R. L., and G. A. Antonelis. 1991. Impacts of the 1982-1983 El Niño on the northern fur seal population at San Miguel Island, California. Pp. 75-83, *In*: Trillmich, F., and K. Ono (eds.), Pinnipeds and El Niño: Responses to Environmental Stress. Springer-Verlag, New York. 293 pp.

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.

Fiscus, C. F. 1983. Fur seals and island. *In:* Background papers submitted by the United States to the 26th annual meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission, Washington, D.C., March 28-April 5, 1983. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Gerrodette, T., D. Goodman, and J. Barlow. 1985. Confidence limits for population projections when vital rates vary randomly. Fish. Bull. 83(3):207-217.

Hill, P. S, and D. P. DeMaster. 1998. Alaska marine mammal stock assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-97. 166 pp.

Julian, F. 1997. Cetacean mortality in California gillnet 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: 1990-1995. Fish. Bull. 96:271-284.

Kajimura, H. 1984. Opportunistic feeding of the northern fur seal, *Callorhinus ursinus*, in the eastern North Pacific Ocean and eastern Bering Sea. NOAA Tech. Rep. NMFS-SSRF-779. 49 pp.

Lander, R. H. 1981. A life table and biomass estimate for Alaskan fur seals. Fishery Research (Amsterdam) 1:55-70.

Lander, R. H., and H. Kajimura. 1982. Status of northern fur seals. FAO Fisheries Series 5:319-345.

Lynn, R. J., T. Baumgartner, J. Garcia, C. A. Collins, T. L. Hayward, K. D. Hyrenbach, A. W. Mantyla, T. Murphree, A. Shankle, F. B. Schwing, K. M. Sakuma, and M. J. Tegner. 1998. The state of the California Current, 1997-1998: transition to El Niño conditions. CalCOFI Report 39:25-49.

Melin, S. R. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Melin, S. R., and R. L. DeLong. 1994. Population monitoring of northern fur seals on San Miguel Island, California. Pp. 137-141, *In:* Sinclair, E. H. (ed.), Fur seal investigations, 1992. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-45. 190 pp.

Melin, S. R., and R. L. DeLong. 2000. Population monitoring studies of northern fur seals at San Miguel Island, California. Pp. 41-51, *In:* Robson, B. W. (ed.), Fur seal investigations, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-113. 101 pp.

Melin, S. R., R. L. DeLong, and J. R. Thomason. 1996. Population monitoring studies of northern fur seals at San Miguel Island, California. Pp. 87-102, *In:* Sinclair, E.H. (ed.), Fur seal investigations, 1994. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-69. 144 pp.

National Marine Fisheries Service. 1993. Final Conservation Plan for the northern fur seal (*Callorhinus ursinus*). Prepared by the National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, and the Office of Protected Resources, NMFS, Silver Spring, MD. 80 pp.

Roppel, A. Y. 1984. Management of northern fur seals on the Pribilof Islands, Alaska, 1786-1981. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-4. 32 pp.

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.

York, A. E. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

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HAWAIIAN MONK SEAL (*Monachus schauinslandi*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

Hawaiian monk seals are distributed throughout the Northwestern Hawaiian Islands (NWHI) in six main reproductive subpopulations at French Frigate Shoals, Laysan and Lisianski Islands, Pearl and Hermes Reef, and Midway and Kure Atoll. Small numbers also occur at Necker, Nihoa, and the main Hawaiian Islands, primarily at Niihau. Genetic variation in Hawaiian monk seals is extremely low and may reflect both a long-term history at low population levels and more recent human influences (Kretzmann et al., 2001). The tendency for genetic drift may have been relatively large, due to the small size of different island/atoll subpopulations. However, 10-15% of these seals migrate among the subpopulations (Johnson and Kridler 1983; National Marine Fisheries Service [NMFS] unpubl. data) and, to some degree, this movement should counter the development of separate genetic stocks. Genetic variation among the different island populations is low (Kretzmann et al., 1997; 2001).

Demographically, the different island subpopulations have exhibited considerable independence. For example, abundance at French Frigate Shoals grew rapidly from the 1950s-1980s, while other subpopulations declined rapidly. Variability in past population trends may be partially explained by changes in levels of human disturbance (Gerrodette and Gilmartin 1990; Ragen 1999). Current demographic variability among the subpopulations probably reflects a combination of age structure effects resulting from different recent histories and variable environmental conditions. While research and recovery activities may focus on the problems of single island/atoll subpopulations, the species is managed as a single stock.

POPULATION SIZE

The best estimate of the total population size is 1,463. This estimate is the sum of counts at the six main Northwest Hawaiian Islands subpopulations, an extrapolation of counts at Necker and Nihoa Islands, and counts at the main Hawaiian Islands. Abundance of the main reproductive subpopulations is best estimated using the number of seals identified at each site. Individual seals are identified by flipper-tags and applied bleach-marks, and distinctive natural features such as scars and pelage patterns. Flipper-tagging of weaned pups began in the early 1980s and the majority of the seals in the main reproductive subpopulations can be identified on the basis of those tags. In 2000, identification efforts were conducted during two- to five-month studies at all main reproductive sites except Midway Atoll, where studies lasted 8 months. A total of 1,303 seals (including 191 pups) were observed at the main reproductive subpopulations in 2000 (Johanos and Baker, 2001). Removal analyses in previous years and sighting probability calculations suggest that 90% or more of the seals were identified at each site (i.e., any negative bias should be less than 10%).

Monk seals also occur at Necker and Nihoa Islands, where counts are conducted once or a few times in a single year. Abundance is estimated by correcting the mean of all beach counts accrued over the past five years. The mean (±SD) of all counts (excluding pups) conducted during 1996-2000 were 18.2(± 8.6) at Necker Island and 20.0 (±4.2) at Nihoa Island (Johanos and Ragen 1999a,b; Johanos and Baker 2000, 2001, in press). The relationship between mean counts and total abundance at the reproductive sites indicates that the total abundance can be estimated by multiplying the mean count by a correction factor (±SE) of 2.89 (±0.06, NMFS unpubl. data). Resulting estimates (plus the average number of pups known to have been born during 1996-2000) are 53.6 (±24.9) at Necker Island and 61.1 (±12.1) at Nihoa Island.

A number of seals are also distributed throughout the main Hawaiian Islands. These include naturally occurring seals and any animals remaining from 21 seals released around the islands in 1994. All but two were subsequently resighted near their release sites, but their survival to 2000 is unknown, because there is no formal re-sighting effort in the main Hawaiian Islands. The first systematic monk seal survey was conducted around the main Hawaiian Islands in 2000. During this survey, 41 seals were identified from aircraft, and another four animals not seen from the air were confirmed present from concurrent ground observations. Thus, 45 seals were identified in the Main Hawaiian Islands in 2000 (Baker and Johanos 2001).

Minimum Population Estimate

The total number of seals identified at the main reproductive sites is the best estimate of minimum population

size at those sites (i.e., 1,303 seals). Minimum population sizes for Necker and Nihoa Islands (based on the formula provided by Wade and Angliss (1997)) are 37 and 52, respectively. The minimum abundance estimate for the main Hawaiian Islands based upon the aerial survey is 45 seals. The minimum population size for the entire stock (species) is the sum of these estimates, or 1,437 seals.

Current Population Trend

The total of mean non-pup beach counts at the main reproductive subpopulations in 2000 is approximately 60% lower than in 1958. From 1985 to 2000, the average rate of decline was approximately 3% yr^{-1}, although the counts have been stable since 1993 (Fig. 1). Further decline is likely, due to high juvenile mortality and an inverted age structure which will result in reduced reproductive recruitment in the largest subpopulation (French Frigate Shoals). This anticipated trend may be underway as evidenced by declining beach counts and births at French Frigate Shoals during 1998-2000. During recent years, decreases at French Frigate Shoals have been offset by increases at other subpopulations.

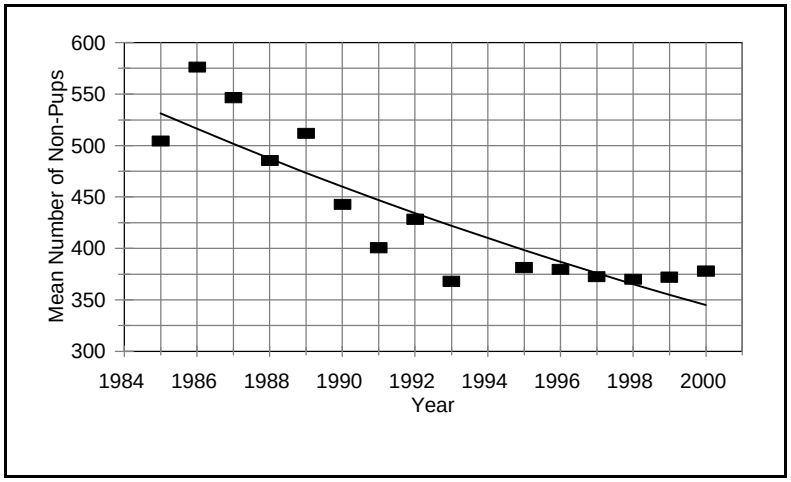

Figure 10. Mean beach counts of Hawaiian monk seals (non-pups) at the main reproductive rookeries (excluding Midway Atoll), 1985-2000.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Assuming mean beach counts are a reliable index of total abundance, the current net productivity rate for this species is -0.03 yr^{-1} (loglinear regression of beach counts of non-pups, 1985-2000; $R^2 = 0.79$, $P<0.001$). This trend is largely due to a severe decline at French Frigate Shoals, where non-pup beach counts decreased by 60% from 1989 - 2000. Populations at Laysan and Lisianski Islands have remained relatively stable since approximately 1990.

Contrary to trends at the above sites, the subpopulation at Kure Atoll has grown at ca. 5% yr^{-1} since 1983 (loglinear regression of beach counts, 1983-2000; $R^2 = 0.85$, $P<0.001$), due largely to decreased human disturbance and introduced females. The subpopulation at Pearl and Hermes Reef has grown at approximately 6% yr^{-1} since 1983 (loglinear regression of beach counts, 1983-2000; $R^2 = 0.84$, $P<0.001$). Growth of the Pearl and Hermes population may be slowing slightly, as previous to 1999 the growth rate averaged 7%yr^{-1}. This latter annual growth rate is the best indicator of the maximum net productivity rate (R_{max}) for this species. Finally, the small subpopulation at Midway Atoll continues to show signs of recovery.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,437) times one half the maximum net growth rate for this stock (½ of 7%) times a recovery factor of 0.1 (for an endangered species, Wade and Angliss 1997), which yields a PBR of 5 monk seals per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Human-related mortality has caused two major declines of the Hawaiian monk seal (Ragen 1999). In the 1800s, this species was decimated by sealers, crews of wrecked vessels, and guano and feather hunters (Dill and Bryan 1912; Wetmore 1925; Clapp and Woodward 1972). Several subpopulations may have been driven extinct; for example, no seals were seen at Midway Atoll during a 14-month period in 1888-89, and only a single seal was seen during three months of observations at Laysan Island in 1912-13 (Bailey 1952). A survey in 1958 indicated at least partial recovery of the species in the first half of this century (Rice 1960). However, subsequent surveys revealed that all subpopulations except French Frigate Shoals declined severely after the late 1950s (or earlier). This second decline has not been

explained at Pearl and Hermes Reef, or Lisianski and Laysan Islands. At Kure Atoll, Midway Atoll, and French Frigate Shoals, trends appear to have been determined by the pattern of human disturbance from military or U.S. Coast Guard activities. Such disturbance is believed to have caused pregnant females to abandon prime pupping habitat and nursing females to abandon their pups (Kenyon 1972; Gerrodette and Gilmartin 1990), resulting in decreased in pup survival, which led to poor reproductive recruitment, low productivity, and population decline.

Fishery Information

Detrimental fishery interactions with monk seals include: operations/gear conflict, seal consumption of discarded fish, and competition for prey. Entanglement of monk seals in fishing gear, which is believed to originate outside the Hawaiian archipelago, is described in a separate section below. Since 1982, fishery-related monk seal deaths have included the following: one seal died from entanglement in the bridle rope of lobster trap (1986; NMFS, unpubl. data), another entanglement death in an illegally set gill net off the western shore of Oahu (1994; NMFS, unpubl. data), and one died from ingestion of a recreational fish hook and probable drowning off the island of Kauai (1995; NMFS, unpubl. data). A total of 20 seals have been observed with embedded fish hooks during 1982-2000. The hooks were not always recovered and it was not possible to attribute each hooking event to a specific fishery. Among hooks that could be identified, sources included recreational fisheries (esp. for *Caranx* sp. in the main Hawaiian Islands), federal and state bottomfish and federal longline fisheries (NMFS unpubl. data). For the purposes of a recent Biological Opinion, hookings conservatively judged to be of commercial origin were summarized (NMFS 2001). Importantly, the majority of these deaths and injuries have been observed incidentally during land-based research or other activities; monk seal/fisheries interactions need to be monitored to assess the rate of fisheries-related injury or mortality for this species.

Four fisheries may interact with Hawaiian monk seals. The NWHI lobster fishery began in the late 1970s, and developed rapidly in the early 1980s (Polovina, 1993). Annual landings peaked in 1985 (1.92 million lobsters) and 1986 (1.69 million lobsters; Haight and DiNardo 1995). Thereafter, the fishery declined and was closed temporarily in 1993 due to low spawning stock biomass of spiny lobster. Since 1994, landings remained lower than in the mid- to late 1980s, while catch of slipper lobster increased in some areas. The number of vessels in the fishery increased from four in 1983 to 17 in 1985, then ranged from 0-12 during 1991-2000 (Dollar 1995; DiNardo et al. 1998; Kawamoto and Pooley, 2000). Historically, both effort and landings have been concentrated at Gardner Pinnacles, Maro Reef, Necker Island, and St. Rogatien Bank (Clarke and Todoki 1988; Polovina and Moffitt 1989). However, spatial management of the NWHI lobster fishery began in 1998 with the formation of four management areas: Necker Island (Area 1), Maro Reef (Area 2), Gardner Pinnacles (Area 3), and all remaining banks from Nihoa Island in the east to Kure Atoll in the west (Area 4). This approach was adopted in an effort to prevent local depletion of lobster stocks at Necker Island, Maro Reef, and Gardner Pinnacles and to disperse fishing effort, which in recent years had been limited to Necker Island and Maro Reef. As a result of the new management approach, lobsters were taken from Area 4, which, until 1998, had not been fished since the early 1990's (DiNardo et al.1998; Kawamoto and Pooley 2000). Summaries of catch by area, trends and available data on bycatch are published in annual reports, the most recent being Kawamoto and Pooley (2000). Neither incidental mortality nor serious injury have been observed by NMFS observers of the lobster fishery through 2000. As was noted, one mortality was documented in 1986; a monk seal drowned after becoming entangled in the bridle rope of an actively fishing lobster trap near Necker Island. The potential for indirect interaction due to competition for prey is being investigated (see Habitat Issues below).

NMFS closed the Northwestern Hawaiian Islands lobster fishery in 2000 due to uncertainty in the estimates of biomass, and the fishery remains closed to date. President Clinton's Executive Order (1/18/2001) creating the Northwest Hawaiian Islands coral reef ecosystem reserve may preclude some lobster fishing in the NWHI, but this issue has yet to be resolved.

The NWHI bottomfish fishery has been reported to interact with monk seals. This fishery occurred at low levels (< 50 t per year) until 1977, steadily increased to 460 metric tons in 1987, then dropped to 284 metric tons in 1988, and varied from 119 - 201 metric tons per year from 1989-2000 (Kawamoto 1995; Moffitt, pers. comm.). The number of vessels rose from 19 in 1984 to 28 in 1987, and then varied from 10 to 17 in 1988 through 2000 (Kawamoto 1995; Moffitt, pers. comm.). Currently, the bottomfish fishery remains open, although its area of operation has been substantially restricted by President Clinton's Executive Order (1/18/2001). The Agency is preparing an Environmental Impact Statement and a Section 7 Biological Opinion on the operation of the fishery. The fishery was monitored by

observers from October 1990 to December 1993 (ca. 13% coverage), but is currently monitored by the State of Hawaii using logbooks. However, the State logbook does not include information on protected species and, therefore, the nature and extent of interactions with monk seals cannot be assessed from logbooks. Fishers, however, are required to report all incidental mortality and injury within 48 hours of their return to port (pursuant to MMPA section 118(e)); no such mortality or injury has been reported since 1994 when the MMPA was amended to include section 118. Nitta and Henderson (1993) evaluated observer data from 1991-92 and reported an interaction rate of one event per 34.4 hours of fishing, but they do not provide a confidence interval for their estimate. The authors documented observer reports of seals taking bottomfish and bait off fishing lines, and observer reports of seals attracted to discarded bottomfish bycatch. Hookings and other sources of injury resulting from the Federal bottomfish fishery are documented and considered in a recent NMFS Biological Opinion (NMFS 2001). The ecological effects of this fishery on monk seals (e.g., competition for prey or alteration of prey assemblages by removal of key predator fishes) are unknown. However, published studies on monk seal prey selection based upon scat/spew analysis and seal-mounted video, rarely revealed evidence that monk seals fed on families of bottomfish which contain commercial species (many prey items recovered from scats and spews were identified only to the level of family; Goodman-Lowe 1998, Parrish et al. 2000). Fatty acid signature analysis is incomplete regarding the importance of commercial bottomfish in the monk seal diet, but this methodology continues to be pursued.

A third fishery in which past interactions with monk seals were documented was the pelagic longline fishery. This fishery targets swordfish and tunas, primarily, and does not compete with Hawaiian monk seals for prey. The fishery began in the 1940s, and operated at a relatively low level (< 5000 t per year) until the mid-1980s. In 1987, 37 vessels participated, but by 1991, the number had grown to 141 (Ito, 1995). The number of active vessels ranged from 103-141 during 1991-2000. Entry is currently limited to a maximum of 164 vessels (Ito and Machado, 1999). Total landings ranged from 8,100-13,000 metric tons during 1991-2000 (Ito, pers. comm.). While most of the fishery has operated outside of the NWHI Exclusive Economic Zone, the rapid expansion raised concerns about the potential for interactions with protected species, including the monk seal. Evidence of interactions began to accumulate in 1990, including at least two hooked seals (included in hookings reported above) and 13 unusual seal wounds thought to have resulted from interactions. In response, NMFS established a permanent Protected Species Zone extending 50 nautical miles around the NWHI and the corridors between the islands in October 1991. Subsequent shore-based observations of seals have found no further evidence of interactions with the longline fishery after establishment of the Protected Species Zone. At present, interactions with protected species are assessed using Federal logbooks and observers (4-5% coverage), which may lack sufficient statistical power to estimate monk seal mortality/serious injury rates from longline interactions. However, since 1991, there have been no observed or reported interactions of this fishery with monk seals.

There have also been interactions between recreational fisheries and monk seals in both the NWHI and around the main Hawaiian Islands. At least three seals have been hooked at Kure Atoll, but such incidents should no longer occur at this site because the atoll was vacated by the U.S. Coast Guard in 1993. In the main Hawaiian Islands, one seal was found dead in an offshore (non-recreational) gillnet in 1994 and a second seal was found dead with a recreational hook lodged in its esophagus. A total of 10 seals have been observed with embedded hooks in the main Hawaiian Islands during 1989-2000 (NMFS unpubl. data). Several incidents involved hooks used to catch ulua (Caranx spp.). A sport fishing charter company recently ceased operations at Midway Atoll. To the extent that sport fishing occurs in the future at Midway, the potential for monk seals to be harmed by hooks will increase at that site.

Interest in the harvest of precious coral in the NWHI represents a potential for future interactions with monk seals. The impact that removal of precious corals might have on monk seal prey resources and foraging habitat is unknown. However, recent studies of seals with satellite transmitters and surveys using manned submersibles indicate that some seals forage at patches of precious gold corals occurring over 500m in depth (Parrish et al., 2002). The recruitment rate of gold coral is unknown, but thought to be slow, raising concern that coral harvesting could have negative long-term impacts on monk seal foraging habitat. As a result, the Western Pacific Regional Fisheries Management Council has recommended regulations to suspend or set to zero annual quotas for gold coral harvest at specific locations until data on impacts of such harvests become available.

Table 1. Summary of incidental mortality of Hawaiian monk seals due to commercial and recreational fisheries since 1990 and calculation of annual mortality rate. n/a indicates that sufficient data are not available.

Fishery Name	Years	Range of # of vessels per year	Data type	Range of observer coverage	Total observed mort.	Estimated mort. (in given years)	Mean annual mort.
NWHI lobster	91-00	0-12	Observer Log book	0-100%	0	n/a	n/a
NWHI Bottomfish	91-00	11-17	n/a	n/a	n/a	n/a	n/a
Pelagic longline	91-00	103-141	Observer Log book	4-5%	0	n/a	n/a
Recreational	91-95	n/a	n/a	n/a	2†	n/a	n/a

† Data collected incidentally.

Fishery Mortality Rate

Data are unavailable to fully assess interaction with specific fisheries in Hawaii, thus one cannot conclude that the total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR. Therefore, total fishery mortality and serious injury cannot be considered to be insignificant and approaching a rate of zero. Monk seals also continue to die from entanglement in North Pacific fishing gear and other debris (likely originating from various countries), and NMFS along with partner agencies, is pursuing a program to mitigate this source of mortality (see below).

Direct fishery interactions with monk seals remains to be thoroughly evaluated and the information above represents only observed interactions. Without further study, an accurate estimate cannot be determined. In addition, interactions may be indirect (i.e., involving competition for prey or consumption of discards from the bottomfish fishery) and, to date, the extent or consequences of such indirect interactions remain the topic of ongoing investigation.

Entanglement in Marine Debris

Hawaiian monk seals become entangled in fisheries and other marine debris at rates higher than reported for other pinnipeds (Henderson 2001). A total of 204 cases of seals entangled in fishing gear or other debris have been observed through 2000 (Henderson 2001; NMFS, unpubl. data), including six documented mortalities resulting from entanglement in fisheries debris (Henderson 1990, 2001; NMFS, unpubl. data). The types of fishing gear fouling the reefs and beaches of the NWHI and entangling monk seals is not among types used in fisheries conducted in the NWHI. For example, trawl net and monofilament gillnet accounted for approximately 35% and 34% of the debris removed from reefs in the NWHI by weight, and trawl net alone accounted for 88% of the debris by frequency (Donohue et al. 2001). Yet there are no commercial trawl fisheries in Hawaii.

The NMFS and partner agencies continue to pursue an ambitious effort to mitigate impacts of marine debris on monk seals as well as turtles, coral reefs and other wildlife. Marine debris is removed from beaches and entangled seals during annual population assessment activities at the main reproductive sites. Efforts to remove potentially entangling marine debris from reefs surrounding monk seal haulout sites are growing. During 1996-2000 debris survey and removal efforts, 78,875 kg of derelict net and other debris were removed from the coral reef habitat in the NWHI (Donohue et al. 2000, Donohue et al. 2001; Donohue, pers. comm). Using funds dedicated to marine debris mitigation, this effort was greatly expanded in 2001.

Other Mortality

Since 1982, 23 seals died during rehabilitation efforts; additionally, two died in captivity, two died when captured for translocation, one was euthanized (an aggressive male known to cause mortality), three died during captive research and three died during field research (Baker and Johanos, *in press*).

In 1986, a weaned pup died at East Island, French Frigate Shoals, after becoming entangled in wire left when the U.S. Coast Guard abandoned the island three decades earlier. In 1991, a seal died after becoming trapped behind an eroding seawall on Tern Island, French Frigate Shoals. This seawall continues to erode and poses an ongoing threat

to the safety of seals and other wildlife.

The only documented case of illegal killing of an Hawaiian monk seal occurred when a resident of Kauai killed an adult female in 1989.

Other sources of mortality which are (or may be) impeding the recovery of this subpopulation include single and multiple male aggression (mobbing), shark predation, and disease/parasitism. When multiple males attempt to mount and mate with an adult female or immature animal of either sex, injury or death of the attacked seal often results. The resulting increase in female mortality appears to have been a major impediment to recovery at Laysan and Lisianski Islands. Since 1982, at least 67 seals have died or disappeared after suffering multiple male aggression at Laysan Island. Multiple male aggression has also been documented at French Frigate Shoals, Kure Atoll, and Necker Island. Multiple male aggression is thought to be related to an imbalance in adult sex ratios, with males outnumbering females. In 1994, 22 adult males were removed from Laysan Island, and only three seals are thought to have died from mobbing at this site since their removal (1995-2000). Such imbalances in the adult sex ratio are more likely to occur when populations are reduced (Starfield et al. 1995).

In addition to mobbing, aggressive attacks by single adult males have resulted in several monk seal mortalities. This was most notable at French Frigate Shoals in 1997, where at least 8 pups died as a result of adult male aggression. Many more pups were likely killed in the same way but the cause of their deaths could not be confirmed. Two males that killed pups in 1997 were observed exhibiting aggressive behavior toward pups at the beginning of the 1998 pupping season. Both males were translocated to Johnston Atoll, 870 km to the southwest. Subsequently, mounting injury to pups have decreased.

Shark-related injury and mortality incidents may have increased in the late 1980s and early 1990s at French Frigate Shoals, but such mortality was probably not the primary cause of the decline at this site (Ragen 1993). However, indications are that shark predation has accounted for a significant portion of pup mortality in the last few years. At French Frigate Shoals in 1999, 17 pups were observed injured by large sharks, and at least 3 were confirmed to have died from shark predation (Johanos and Baker, 2001). Assigning cause of death to shark predation is problematic, as predation events are rarely observable. However, it is believed that as many as 25 pups of a total 92 born at French Frigate Shoals in 1999 were killed by sharks. In 2000, five pups were known to have been attacked by large sharks, and at least one died from shark predation. As many as five other pups are believed to have been similarly killed. NMFS is working with USFWS to develop a strategy to reduce shark predation on monk seal pups. .

The potential causes of high pup mortality, including shark predation, disease, male aggression and food limitation are currently being investigated at French Frigate Shoals. While virtually all wild monk seals carry parasites after they begin to forage, the role of parasitism in monk seal mortality is unknown. Disease effects on monk seal demographic trends is also uncertain. In 2000, base line health screening was conducted on monk seals from Laysan and Lisianski Islands, and Midway Atoll.

STATUS OF STOCK

In 1976, the Hawaiian monk seal was designated depleted under the Marine Mammal Protection Act of 1972 and as endangered under the Endangered Species Act of 1973. The species is assumed to be well below its optimum sustainable population (OSP) and, since 1985, has declined on average approximately 3% per year. Therefore, the Hawaiian monk seal is characterized as a strategic stock.

Habitat Issues

Vessel Groundings pose a continuing threat to monk seals and their habitat. On 16 October 1998 the *Paradise Queen II*, a lobster fishing vessel, ran aground on the eastern edge of Kure Atoll. In 2000, vessel fragments remained on the reef and shoreline of Green Island. On occasion, monk seals land on wreck debris. During an initial clean up effort, accessible hazardous material and lobster traps were removed. In subsequent years, several hundred traps washed ashore and were removed from Green Island. Less than 15 traps were found ashore during 2000.

Another grounding occurred on 6 June 2000 when the 77 ft longliner *Swordman I* ran aground on the perimeter reef of Pearl and Hermes Atoll four miles northeast of Southeast Island. The crew was rescued by the NMFS monk seal field personnel and transported to a nearby vessel. Of 81,200 gallons of fuel on board; 79,000 gallons were recovered and the remainder spilled. An oil spill response crew evaluated the scene one week later and determined that impacts to wildlife and coral reefs were minimal. No evidence of oiling or other impacts to Hawaiian monk seals were found.

Salvage crews subsequently spent 2 weeks cleaning the vessel and preparing it for removal from the reef. On July 27, 2000 the salvage tug *American Salvor* removed the *Swordman I* from the perimeter reef and sank it in deep water.

Available data indicate that the substantial decline at French Frigate Shoals was related to lack of available prey and subsequent emaciation and starvation. Two leading hypotheses to explain the lack of prey are 1) the local population reached its carrying capacity in the 1970s and 1980s, diminishing its own food supply, and 2) carrying capacity was simultaneously reduced by changes in oceanographic conditions and a subsequent decline in productivity (Polovina et al. 1994; Craig and Ragen 2000).

Studies are also being conducted to identify and characterize at-sea habitat use. In 2000, 42 seals of various ages and both sexes were fitted with satellite-linked dive recorders to track movements and dive patterns. In addition, a prey selection study using identification of prey hard parts in scats and spewings has been published (Goodman-Lowe 1998).

Since 1979, human disturbance of seals in their terrestrial habitat has been limited primarily to Kure and Midway Atolls. The U.S. Coast Guard LORAN station at Kure Atoll closed in 1992 and vacated in 1993. Historically, human activities led to the near extinction of the resident monk seal population at Midway both in the late 1800s, and again in the 1960s. The population failed to recover in the 1970s and 1980s, but has recently grown due to immigration from nearby sites. The U.S. Naval Air Facility at Midway closed in 1993 and following clean-up and restoration activities, jurisdiction was transferred in 1997 to the U.S. Fish and Wildlife Service, which manages the atoll as a National Wildlife Refuge. A private company which had provided tourist activities (e.g., scuba diving and sport fishing), as well as harbor services, terminated their operations at Midway Atoll in 2002. As a result, the level of human activity that could impact monk seals at the site has diminished. Any future development which might increase access to the Refuge will need careful management and monitoring to prevent further human disturbance. Disturbance at sea (e.g., direct and indirect fisheries interactions) may also impede recovery. As described above, however, the possible types of disturbance at sea cannot yet be characterized or quantified.

Another important habitat issue is a degrading seawall at Tern Island, French Frigate Shoals. Tern Island is the site of the U.S. Fish and Wildlife refuge station, and is one of two sites in the NWHI accessible by aircraft. The island and the runway have played a key role in efforts to study the local monk seal population and to mitigate its severe and ongoing decline. During World War II, the U.S. Navy enlarged the island to accommodate the runway. A sheet-pile seawall was constructed to maintain the modified shape of the island. Degradation of the seawall is creating entrapment hazards for seals and other wildlife and is threatening to erode the runway. Erosion of the sea wall has raised concerns about the potential release of toxic wastes into the ocean. The loss of the runway could lead to the closure of the Fish and Wildlife Service station at the site and would thereby reduce on-site management of the refuge. The loss of the runway and refuge station would also hinder research and management efforts to recover the monk seal population.

REFERENCES

Bailey, A. M. 1952. The Hawaiian monk seal. Museum Pictorial, Denver Museum of Natural History 7:1-32.

Baker, J. D. and T. C. Johanos. 2001. First Survey of Hawaiian Monk Seals in the Main Hawaiian Islands. Abstract. Fourteenth Biennial Conference on the Biology of Marine Mammals, November 28 - December 3, 2001. Vancouver, B. C.

Baker, J. D. and T. C. Johanos. In press. Effects of research handling on the endangered Hawaiian monk seal. Mar. Mammal Sci.

Clapp, R. B., and P. W. Woodward. 1972. The natural history of Kure Atoll, Northwestern Hawaiian Islands, Atoll Res. Bull. 164:303-304

Clarke, R. P., and A. C. Todoki. 1988. Comparison of three calculations of catch rates of the lobster fishery in the Northwestern Hawaiian Islands. Admin. Rep. H-88-6. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 30 pp.

Craig, M. P. and T. J. Ragen. 1999. Body size, survival, and decline of juvenile Hawaiian monk seals, Monachus schauinslandi. .Marine Mammal Science 15(3): 786-809.

Dill, H. R., and W. A. Bryan. 1912. Report on an expedition to Laysan Island in 1911. U.S. Dept. of Agric. Surv. Bull. 42:1-30.

DiNardo, G. T., W. R. Haight, and J. A. Wetherall. 1998. Status of lobster stocks in the Northwestern Hawaiian Islands, 1995-97, and outlook for 1998. Admin. Rep. H-98-05. Southwest Fisheries Science Center, National

Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 35 pp.

Donohue, M.J., R. Brainard, M. Parke, and D. Foley. 2000. Mitigation of environmental impacts of derelict fishing gear through debris removal and environmental monitoring. Issue paper in International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment, 6-11 August 2000, Honolulu, Hawaii. Hawaiian Islands Humpback Whale National Marine Sanctuary publication, 726 S Kihei Road, Kihei, HI 96753, hawaiian@nms.noaa.gov.

Donohue, M.J., R.C. Boland, C.M. Sramek, and G.A. Antonelis. 2001. Derelict fishing gear in the Northwestern Hawaiian Islands: diving surveys and debris removal in 1999 confirm threat to coral reef ecosystems. Marine Pollution Bulletin 42(12):1301-1312.

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. Dep. Commer. NOAA Technical Memorandum. NMFS-SWFSC-300. 276 p.

Gerrodette, T. M., and W. G. Gilmartin. 1990. Demographic consequences of changed pupping and hauling sites of the Hawaiian monk seal. Conserv. Biol. 4:423-430.

Goodman-Lowe, G. D. 1998. Diet of the Hawaiian monk seal (*Monachus schauinslandi*) from the northwestern Hawaiian islands during 1991 to 1994. Marine Biology 132:535-546.

Haight, W. R., and G. T. DiNardo. 1995. Status of lobster stocks in the Northwestern Hawaiian Islands, 1994. Available Honolulu Lab., Southwest Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Sci. Cent. Admin. Rep. H-95-03, 17 p.

Henderson, J. R. 1990. Recent entanglements of Hawaiian monk seals in marine debris. In R. S. Shomura and M. L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, April 2-7, 1989, Honolulu, Hawaii, p. 540-553. U.S. Dep. Commer., NOAA, Tech. Memo. NMFS-SWFSC-154.

Henderson, J.R. 2001. A Pre- and Post-MARPOL Annex V Summary of Hawaiian Monk Seal Entanglements and Marine Debris Accumulation in the Northwestern Hawaiian Islands, 1982-1998. Marine Pollution Bulletin 42:584-589.

Ito, R. Y. 1995. Annual report of the 1994 Hawaii-based longline fishery. Admin. Rep. H-95-08 Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 36 pp.

Ito, R. Y., and W. A. E. Machado. 1999. Annual report of the Hawaii-based longline fishery in 1998. Admin. Rep. H-99-06. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 62 pp.

Johanos, T. C., and T. J. Ragen (editors). 1999a. The Hawaiian monk seal in the northwestern Hawaiian islands, 1996. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-259. 134p.

Johanos, T. C., and T. J. Ragen (editors). 1999b. The Hawaiian monk seal in the northwestern Hawaiian islands, 1997. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-262. 131p.

Johanos, T. C. and J. D. Baker (editors). 2000. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-292, 125 p.

Johanos, T. C. and J. D. Baker (editors). 2001. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 1999. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-310, 130 p.

Johanos, T. C. and J. D. Baker (editors). In press. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 2000. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-340, 100 p.

Johnson, A. M., and E. Kridler. 1983. Interisland movement of Hawaiian monk seals. 'Elepaio 44(5):43-45.

Kawamoto, K. E. 1995. Northwestern Hawaiian Islands bottomfish fishery, 1994. Admin. Rep. H-95-07. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 26 pp.

Kawamoto, K. E., and S. G. Pooley. 2000. Annual report of the 1998 western Pacific lobster fishery. Admin. Rep. H-00-02. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 38 pp.

Kenyon, K. W. 1972. Man versus the monk seal. J. Mammal. 53(4):687-696.

Kretzmann, M. B., W. G. Gilmartin, A. Meyer, G. P. Zegers, S. R. Fain, B. F. Taylor, and D. P. Costa. 1997. Low genetic variability in the Hawaiian monk seal. Conserv. Biol. 11(2):482-490.

Kretzmann, M. B., N. J. Gemmell, and A. Meyer. 2001. Microsatellite analysis of population structure in the endangered Hawaiian monk seal. Conserv. Biol. 15(2):457-466.

Goodman-Lowe, G. D. 1998. Diet of the Hawaiian monk seal (*Monachus schauinslandi*) from the Northwestern Hawaiian islands during 1991 to 1994. Marine Biology 132:535-546.

National Marine Fisheries Service. 2001. Biological Opinion for the Management of the Bottomfish and Seamount Groundfish Fisheries in the Western Pacific Region According to the Fishery Management Plan for the Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region.

Nitta, E. T., and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Parrish, F. A., M. P. Craig, T. J. Ragen, G. J. Marshall, and B. M. Buhleier. 2000. Identifying diurnal foraging habitat of endangered Hawaiian monk seals using a seal-mounted video camera. Mar. Mamm. Sci. 16:392-412.

Parrish, F.A., K Abernathy, G.J. Marshall, and B.M. Buhleier. 2002. Hawaiian monk seals (Monachus schauinslandi) foraging in deepwater coral beds. Mar. Mamm. Science 18:244-258.

Polovina, J. J. 1993. The lobster and shrimp fisheries in Hawaii. Mar. Fish. Rev. 55(2):28-33.

Polovina, J. J., G. T. Mitchum, N. E. Graham, M. P. Craig, E. E. DeMartini, and E. N. Flint. 1994. Physical and biological consequences of a climate event in the central North Pacific. Fish. Ocean. 3:15-21.

Polovina, J. J., and R. B. Moffitt. 1989. Status of lobster stocks in the Northwestern Hawaiian Islands, 1988. Admin. Rep. H-89-3. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 10 pp.

Pooley, S. G., and K. E. Kawamoto. 1998. Annual report of the 1995-97 western Pacific lobster fishery. Admin. Rep. H-98-09. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 34 pp.

Ragen, T. J. 1993. Status of the Hawaiian monk seal in 1992. Admin. Rep. H-93-05. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 79 pp.

Ragen, T.J. 1999. Human activities affecting the population trends of the Hawaiian monk seal. Pages 183-194 *in* J.A. Musick, ed. Life in the slow lane: Ecology and conservation of long-lived marine animals. American Fisheries Society Symposium 23, American Fisheries Society, Bethesda, MD.

Rice, D. W. 1960. Population dynamics of the Hawaiian monk seal. J. Mammal. 41:376-385.

Starfield, A. M., J. D. Roth, and K. Ralls. 1995. "Mobbing" in Hawaiian monk seals (Monachus schauinslandi): The value of simulation modeling in the absence of apparently crucial data. Conserv. Biol. 9:166-174.

Wade, P. R. and R. P. 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.

Wetmore, A. 1925. Bird life among lava rock and coral sand. The Natl. Geograp. Mag. 48:77-108.

Revised 10/31/2002 (new stock)

HARBOR PORPOISE (*Phocoena phocoena*): Morro Bay Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the Pacific, harbor porpoise are found in coastal and inland waters from Point Conception, California to Alaska and across to Kamchatka and Japan (Gaskin 1984). Harbor porpoise appear to have more restricted movements along the western coast of the continental U.S. than along the eastern coast. Regional differences in pollutant residues in harbor porpoise indicate that they do not move extensively between California, Oregon, and Washington (Calambokidis and Barlow 1991). That study also showed some regional differences within California (although the sample size was small). This pattern stands as a sharp contrast to the eastern coast of the U.S. and Canada where harbor porpoise are believed to migrate seasonally from as far south as the Carolinas to the Gulf of Maine and Bay of Fundy (Polacheck et al. 1995). A phylogeographic analysis of genetic data from northeast Pacific harbor porpoise did not show complete concordance between DNA sequence types and geographic location (Rosel 1992). However, an analysis of molecular variance (AMOVA) of the same data with additional samples found significant genetic differences for four of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (Rosel et al. 1995). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic or migratory, and movement is sufficiently restricted that genetic differences have evolved. Recent preliminary genetic analyses of samples ranging from Monterey Bay, California to Vancouver Island, British Columbia indicate that there is small-scale subdivision within the U.S. portion of this range (Chivers *et al.*, 2002).

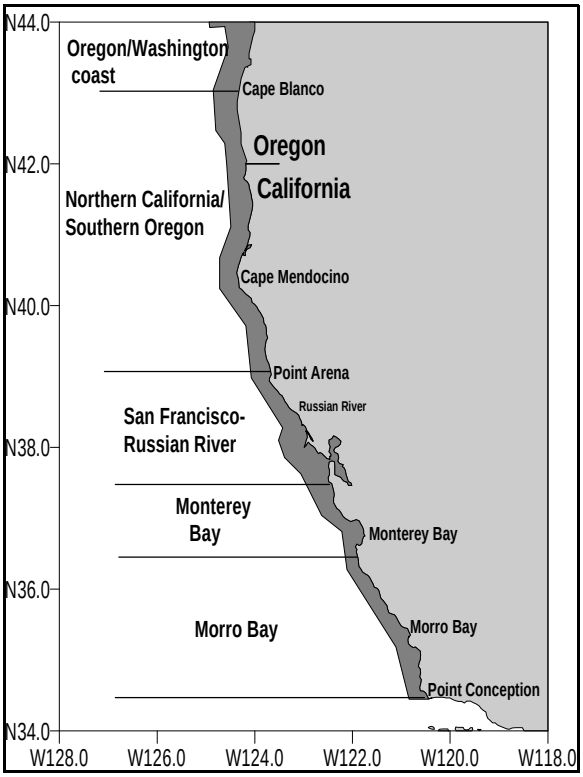

Figure 1. Stock boundaries and distributional range of harbor porpoise along the California/southern Oregon coast. Shaded area represents harbor porpoise habitat (0-200 m) along the U.S. west coast.

In their assessment of harbor porpoise, Barlow and Hanan (1995) recommended that the animals inhabiting central California (defined to be from Point Conception to the Russian River) be treated as a separate stock. Their justifications for this were: 1) fishery mortality of harbor porpoise is limited to central California, 2) movement of individual animals appears to be restricted within California, and consequently 3) fishery mortality could cause the local depletion of harbor porpoise if central California is not managed separately. Although geographic structure exists along an almost continuous distribution of harbor porpoise from California to Alaska, stock boundaries are difficult to draw because any rigid line is (to a greater or lesser extent) arbitrary from a biological perspective. Nonetheless, failure to recognize geographic structure by defining management stocks can lead to depletion of local populations. Based on recent genetic findings (Chivers *et al.*, 2002), California coast stocks were re-evaluated and significant genetic differences were found among 4 identified sampling sites. Revised stock boundaries are presented here based on these genetic data and density discontinuities identified from aerial surveys, resulting in six California/Oregon/Washington stocks where previously there had been four (Carretta *et al.* 2001a). The stock boundaries for animals that occur in California/southern Oregon waters are shown in Figure 1. For the 2002 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, other Pacific coast harbor porpoise stocks include: 1) a Monterey Bay stock, 2) a San Francisco-Russian River stock, 3) a northern California/southern Oregon stock, 4) an Oregon/Washington coast stock, 5) an Inland Washington stock, 6) a Southeast Alaska stock, 7) a Gulf of Alaska stock, and 8) a Bering Sea stock. Stock assessment reports for Monterey Bay, San Francisco-Russian River, northern California/southern Oregon, Oregon/Washington coast, and Inland Washington waters harbor porpoise

appear in this volume. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Previous estimates of abundance for California harbor porpoise were based on aerial surveys conducted between the coast and the 50-fm isobath during 1988-95 (Barlow and Forney 1994, Forney 1999a). These estimates did not include an unknown number of animals found in deeper waters. Barlow (1988) found that the vast majority of harbor porpoise in California were within the 0-50-fm depth range; however, Green et al. (1992) found that 24% of harbor porpoise seen during aerial surveys of Oregon and Washington were between the 100m and 200m isobaths (55 to 109 fathoms). A systematic ship survey of depth strata out to 90 m in northern California showed that porpoise abundance declined significantly in waters deeper than 60 m (Carretta *et al*. 2001b). A recent analysis of harbor porpoise trends including oceanographic data suggests that the proportion of California harbor porpoise in deeper waters may vary between years (Forney 1999b). In 1999, aerial surveys extended farther offshore (to the 200m depth contour or 15 nmi distance, whichever is farther) to provide a more complete abundance estimate. Based on aerial surveys from 1997-99 under good survey conditions (Beaufort $\leq$ 2, cloud cover $\leq$ 25%) the estimate of abundance for this stock is 932 animals (CV = 0.41).

Minimum Population Estimate

The minimum population estimate for the Morro Bay harbor porpoise stock is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from the 1997-99 aerial surveys, or 669 animals.

Current Population Trend

Analyses of a 1986-95 time series of aerial surveys have been conducted to examine trends in harbor porpoise abundance in central California (Forney, 1995; 1999b). After controlling for the effects of sea state, cloud cover, and area on sighting rates, Forney (1995) found a negative trend in population size; however, that trend was no longer significant when sea surface temperature (a proxy measure of oceanographic conditions) was included in an updated non-linear trend analysis (Forney 1999b). The negative correlation between harbor porpoise sighting rates and sea surface temperatures indicates that apparent trends could be caused by changing oceanographic conditions and movement of animals into and out of the study area. Encounter rates for the 1997 survey, however, were very high (Forney 1999a) despite the warmer sea surface temperatures caused by strong El Niño conditions. These observations suggest that patterns of harbor porpoise movement are not directly related to sea surface temperature, but rather to the more complex distribution of potential prey species in this area. Although encounter rates during the 1999 aerial survey were again higher than in past years, the trend in relative abundance (following methods of Forney 1995) is not statistically significant (p=0.12, Figure 2). More detailed studies of encounter rate patterns in relation to satellite-derived sea surface temperature during 1993-99 are planned to shed light on potential oceanography-related movement patterns of harbor porpoise in this region.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (i.e. females give birth first at age 4 and produce one calf per year until death), the theoretical, maximum-conceivable growth rate of a closed harbor porpoise population was estimated as 9.4% per year (Barlow and Boveng 1991). This maximum theoretical rate may not be achievable for any real population. [Woodley and Read (1991) calculate a maximum growth rate of approximately 5% per year, but their argument for this being a maximum (i.e. that porpoise survival rates cannot exceed those of Himalayan thar) is not well justified.] Population growth rates have not actually been measured for any harbor porpoise population. Because a reliable estimate of the maximum net productivity rate is not available for Morro Bay harbor porpoise, we use the default maximum net productivity rate (R_{MAX}) of 4% for cetaceans (Wade and Angliss 1997) be employed.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (669) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a stock of unknown status; Wade and Angliss 1997), resulting in a PBR of 7.

HUMAN-CAUSED MORTALITY

Fishery Information

The set gillnet fishery for halibut and angel shark operates in the vicinity of Morro Bay and fishing effort here has steadily increased in recent years. California Department of Fish and Game (CDFG) estimated fishing effort for 1996-2001 is 32, 88, 139, 121, 284, and 375 days respectively. The preliminary 2001 estimate of 375 days represents the first three calendar quarters only. Mortality rates of harbor porpoise in the set gillnet fishery in this region are available only from 43 trips observed between 1990-94 (Julian and Beeson 1998), in which one harbor porpoise was killed. This represents a kill rate of 0.023 porpoise/day fished (bootstrap CV = 0.97). Applying this kill rate to the 2001 estimate of fishing effort results in a mortality estimate of 9 porpoise (0.023 * 375 days) through the first three quarters of 2001, which exceeds PBR. Projected mortality levels based on this kill rate and effort levels for 1996-2001 are summarized in Table 1. It should be noted that this kill rate includes sets made in less than 30 fathoms of water, where the potential to entangle porpoise is probably higher. The fishery is now prohibited from fishing inside of 30 fathoms and thus the kill rate may be biased upward if current fishing effort is in compliance with this area closure. However, the kill rate of 0.023 porpoise/day still represents the best available information since the fishery has not been observed in this region since 1994. The white seabass set gillnet fishery also operates in the vicinity of Morro Bay and this fishery has been documented to take harbor porpoise in the past (Norris and Prescott 1961). Effort in the white seabass fishery in the vicinity of Morro Bay for the last five years (1997-2001) has been 0, 26, 7, 61, and 132 days respectively.

In September 2000, the CDFG issued emergency regulations which restricted fishing in the central California halibut set gillnet fishery to waters deeper than 60 fathoms, citing concerns over the continued mortality of common murres and decline of the southern sea otter population. The closure area extended from Point Reyes (N38) to Yankee Point (N36.5) in Monterey County and from Point Arguello (N34.6) to Point Sal (N34.9) in Santa Barbara County (the area from Yankee Point to Point Sal remained open to fishing outside of 30 fathoms). In April 2001, CDFG proposed permanent year-round regulations to eliminate set gillnet fishing inshore of 60 fathoms from Point Reyes to Point Arguello. The emergency closure inside of 60 fathoms has since lapsed and at least several vessels have moved to the Morro Bay area from Monterey since the initial closure. CDFG intends to make permanent a 60-fathom closure for the set gillnet fishery from Point Reyes to Point Arguello by May 2002.

Two harbor porpoise mortalities were inaccurately reported in Marine Mammal Authorization Permit (MMAP) fisher self-reports for the California drift gillnet fishery during 1996-98. Both of the mortalities occurred on an observed fishing trip and were actually short-beaked common dolphins (NMFS, Southwest Fisheries Science Center, unpublished data). This fishery has not previously been known to take harbor porpoise.

STATUS OF STOCK

Based on the last 5 years of fishing effort (1996-2000), mean annual takes are 3.2 porpoise per year, which is less than the PBR of 7 animals, resulting in a "non-strategic" classification. However, fishing effort more than doubled between 1999 and 2000 and has continued to increase in 2001. With current levels of fishing effort, estimated porpoise mortality in 2000 and 2001 would meet or exceed PBR (7 and 9 animals respectively, see Table 1). However, confidence in any mortality estimate for this stock is low, as the kill rate is based on only 43 observed trips between 1990-94 and one observed porpoise mortality in 1990, when the fishery was still permitted to operate inshore of 30 fathoms. With increasing fishing

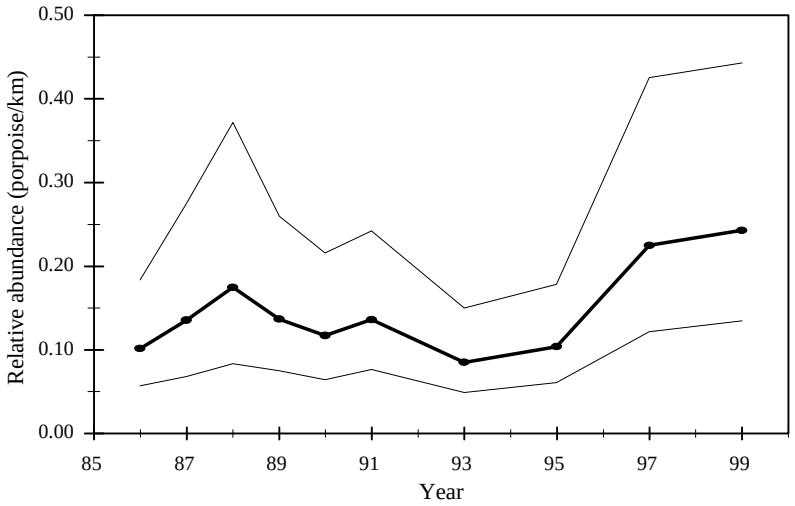

Figure 2. Relative abundance (+/- one standard error) of central California (Pt. Conception to Russian River) harbor porpoise, 1986-99, adjusted for sea state and cloud cover (following methods of Forney 1995). The trend shown includes the range of three California stocks (Morro Bay, Monterey Bay, and San Francisco-Russian River).

effort and no observer program in place, the total fishery mortality for this stock cannot be considered to be insignificant and approaching zero mortality and serious injury rate. A permanent set gillnet closure inside of 60 fathoms is expected to be in place by May 2002 which would effectively eliminate set gillnets from most harbor porpoise habitat and reduce mortality to near zero. Research activities will continue to monitor the population size and to investigate population trends. There are no known habitat issues that are of particular concern for this stock.

Table 1. Summary of available information on incidental mortality and injury of harbor porpoise (Morro Bay stock) in commercial fisheries that might take this species (Cameron and Forney 2000, Carretta 2001, Forney et al., 2001; NMFS/SWFSC, unpublished data). Mean annual takes are based on 1996-2000 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Kill/Day	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA angel shark / halibut and other species large mesh (>3.5") set gillnet fishery	1996	1990-94 observer data	0%	-	0.023[2]	1 (0.97)	3.2 (0.97)[3]
	1997		0%	-		2 (0.97)	
	1998		0%	-		3 (0.97)	
	1999		0%	-		3 (0.97)	
	2000		0%	-		7 (0.97)	
	2001[1]		0%	-		9 (0.97)[1]	
Minimum total annual takes							3.2 (0.97)[3]

[1]Estimate of mortality is based on preliminary effort estimates for the first three calendar quarters of 2001.
[2]Mortality rate is based on 1 observed mortality from 43 observed trips in this region between 1990-94.
[3]Mean annual takes are based on 1996-2000 effort data and 1990-94 kill rates. Mean annual takes using 1997-2001 data would be 5.0 animals.

REFERENCES

Barlow, J. 1988. Harbor porpoise (*Phocoena phocoena*) abundance estimation in California, Oregon and Washington: I. Ship surveys. Fish. Bull. 86:417-432.

Barlow, J. and P. Boveng. 1991. Modeling age-specific mortality for marine mammal populations. Mar. Mamm. Sci. 7(1):84-119.

Barlow, J. and K. A. Forney. 1994. An assessment of the 1994 status of harbor porpoise in California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-205. 17 pp.

Barlow, J. and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. Rept. Int. Whal., Special Issue 16:123-140.

Calambokidis, J. and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. pp. 101-110 In: J. E. Reynolds III and D. K. Odell (eds.) Marine mammal strandings in the United States. NOAA Tech. Rep. NMFS 98.

Carretta, J.V. 2001. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2000. Paper SC/53/SM9 presented to the International Whaling Commission (unpublished). 21pp.

Carretta, J.V., J. Barlow, K.A. Forney, M.M. Muto, and J. Baker. 2001a. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Dep. Commer. NOAA Technical Memorandum NMFS-SWFSC-317. 280pp.

Carretta, J.V., B.L. Taylor, and S.J. Chivers. 2001b. Abundance and depth distribution of harbor porpoise (*Phocoena phocoena*) in northern California determined from a 1995 ship survey. U.S. Fishery Bulletin 99:29-39.

Chivers, S.J., A.E. Dizon, P.J. Gearin, and K.M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises, (Phocoena phocoena), indicated by molecular genetic analyses. Journal of Cetacean Research and Management 4(2):111-122.

Forney, K.A., D.A. Hanan, and J. Barlow. 1991. Detecting trends in harbor porpoise abundance from aerial surveys using analysis of covariance. U.S. Fishery Bulletin 89:367-377.

Forney, K. A. 1999a. The abundance of California harbor porpoise estimated from 1993-97 aerial line-transect surveys. Admin. Rep. LJ-99-02. Southwest Fisheries Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 16 pp.

Forney, K. A. 1999b. Trends in harbor porpoise abundance off central California, 1986-95: Evidence for interannual

changes in distribution? J. Cetacean Res. Manage. 1:73-80.
Gaskin, D. E. 1984. The harbour porpoise (*Phocoena phocoena* L.): regional populations, status, and information on direct and indirect catches. Rep. int. Whal. Commn 34:569-586.
Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and 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 prepared for the Pacific OCS Region.
Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle, and bird mortality for two California gillnet fisheries: 1990-1995. U.S. Fishery Bulletin 96:271-284.
Laake, J. L., J. C. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manag. 61:63-75.
NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-0271.
NMFS, Southwest Region, 501 West Ocean Blvd, Long Beach, CA 90802-4213.
Norris, K.S. and J.H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. Univ. Calif. Publ. Zool. 63(4):291-402.
Polacheck, T., F. W. Wenzel, and G. Early. 1995. What do stranding data say about harbor porpoise (*Phocoena phocoena*). Rep. Int. Whal. Comm., Special Issue 16:169-179.
Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, Univ. Calif. San Diego. 191pp.
Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, Phocoena phocoena, on inter-oceanic and regional scales. Can. J. Fish. and Aquat. Sci. 52:1210-1219.
Wade, P. R. and R. P. 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.
Woodley, T. H. and A. J. Read. 1991. Potential rates of increase of a harbour porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. Can. J. Fish. Aquat. Sci. 48:2429-2435.

Revised 10/31/2002 (new stock)

HARBOR PORPOISE (*Phocoena phocoena*): Monterey Bay Stock

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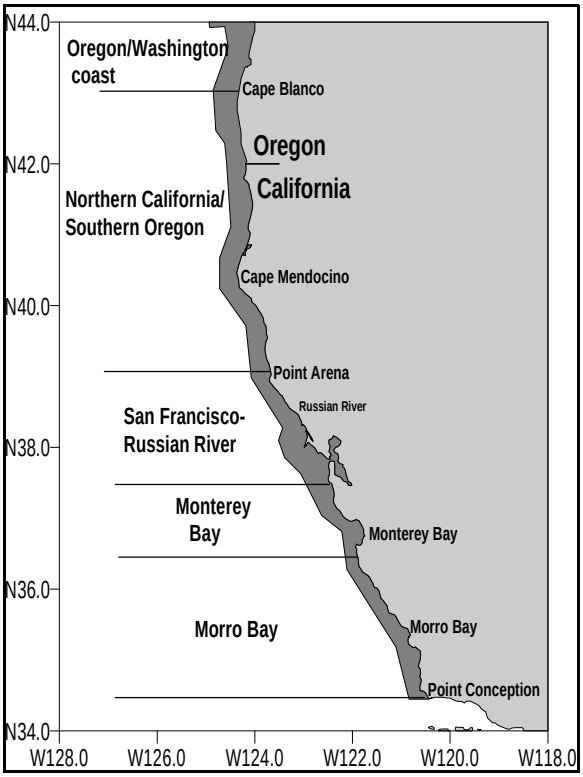

Figure 1. Stock boundaries and distributional range of harbor porpoise along the California/southern Oregon coast. Shaded area represents harbor porpoise habitat (0-200 m) along the U.S. west coast.

In their assessment of harbor porpoise, Barlow and Hanan (1995) recommended that the animals inhabiting central California (defined to be from Point Conception to the Russian River) be treated as a separate stock. Their justifications for this were: 1) fishery mortality of harbor porpoise is limited to central California, 2) movement of individual animals appears to be restricted within California, and consequently 3) fishery mortality could cause the local depletion of harbor porpoise if central California is not managed separately. Although geographic structure exists along an almost continuous distribution of harbor porpoise from California to Alaska, stock boundaries are difficult to draw because any rigid line is (to a greater or lesser extent) arbitrary from a biological perspective. Nonetheless, failure to recognize geographic structure by defining management stocks can lead to depletion of local populations. Based on recent genetic findings (Chivers, *et al*. 2002), California coast stocks were re-evaluated and significant genetic differences were found among 4 identified sampling sites. Revised stock boundaries are presented here based on these genetic data and density discontinuities identified from aerial surveys, resulting in six California/Oregon/Washington stocks where previously there had been four (Carretta *et al.* 2001a). The stock boundaries for animals that occur in California/southern Oregon waters are shown in Figure 1. For the 2002 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, other Pacific coast harbor porpoise stocks include: 1) a Morro Bay stock, 2) a San Francisco-Russian River stock, 3) a northern California/southern Oregon stock, 4) an Oregon/Washington coast stock, 5) a Washington Inland waters stock, 6) a Southeast Alaska stock, 7) a Gulf of Alaska stock, and 8) a Bering Sea stock. Stock assessment reports for Morro Bay, San Francisco-Russian River, northern California/southern Oregon, Oregon/Washington coast, and Inland Washington waters harbor porpoise appear

in this volume. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Previous estimates of abundance for California harbor porpoise were based on aerial surveys conducted between the coast and the 50-fm isobath during 1988-95 (Barlow and Forney 1994, Forney 1999a). These estimates did not include an unknown number of animals found in deeper waters. Barlow (1988) found that the vast majority of harbor porpoise in California were within the 0-50-fm depth range; however, Green et al. (1992) found that 24% of harbor porpoise seen during aerial surveys of Oregon and Washington were between the 100m and 200m isobaths (55 to 109 fathoms). A systematic ship survey of depth strata out to 90 m in northern California showed that porpoise abundance declined significantly in waters deeper than 60 m (Carretta et al. 2001b). A recent analysis of harbor porpoise trends including oceanographic data suggests that the proportion of California harbor porpoise in deeper waters may vary between years (Forney 1999b). In 1999, aerial surveys extended farther offshore (to the 200m depth contour or 15 nmi distance, whichever is farther) to provide a more complete abundance estimate. Based on aerial surveys from 1997-99 under good survey conditions (Beaufort $\leq$ 2, cloud cover $\leq$ 25%) the estimate of abundance for this stock is 1,603 animals (CV = 0.42).

Minimum Population Estimate

The minimum population estimate for the Monterey Bay harbor porpoise stock is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from the 1997-99 aerial surveys, or 1,143 animals.

Current Population Trend

Analyses of a 1986-95 time series of aerial surveys have been conducted to examine trends in harbor porpoise abundance in central California (Forney, 1995; 1999b). After controlling for the effects of sea state, cloud cover, and area on sighting rates, Forney (1995) found a negative trend in population size; however, that trend was no longer significant when sea surface temperature (a proxy measure of oceanographic conditions) was included in an updated non-linear trend analysis (Forney 1999b). The negative correlation between harbor porpoise sighting rates and sea surface temperatures indicates that apparent trends could be caused by changing oceanographic conditions and movement of animals into and out of the study area. Encounter rates for the 1997 survey, however, were very high (Forney 1999a) despite the warmer sea surface temperatures caused by strong El Niño conditions. These observations suggest that patterns of harbor porpoise movement are not directly related to sea surface temperature, but rather to the more complex distribution of potential prey species in this area. Although encounter rates during the 1999 aerial survey were again higher than in past years, the trend in relative abundance (following methods of Forney 1995) is not statistically significant (p=0.12, Figure 2). More detailed studies of encounter rate patterns in relation to satellite-derived sea surface temperature during 1993-99 are planned to shed light on potential oceanography-related movement

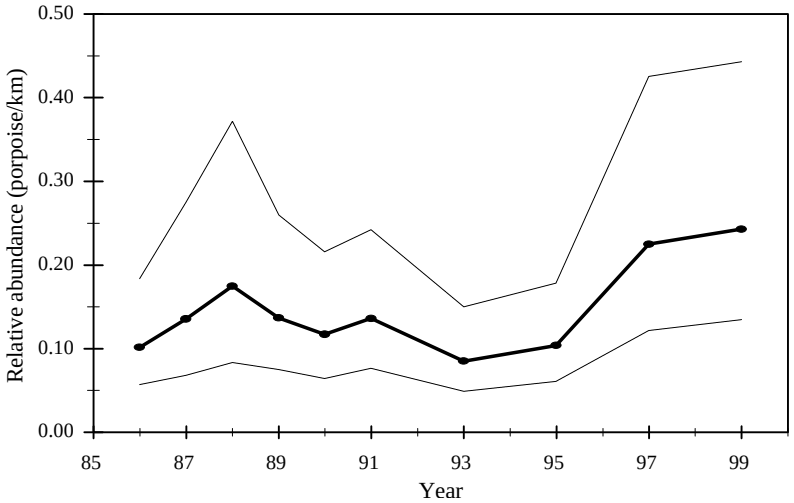

Figure 2. Relative abundance (+/- one standard error) of central California harbor porpoise, 1986-99, adjusted for sea state and cloud cover (following methods of Forney 1995). The trend shown includes the range of three California stocks (Morro Bay, Monterey Bay, and San Francisco-Russian River)

patterns of harbor porpoise in this region.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (i.e. females give birth first at age 4 and produce one calf per year until death), the theoretical, maximum-conceivable growth rate of a closed harbor porpoise population was estimated as 9.4% per year (Barlow and Boveng 1991). This maximum theoretical rate may not be achievable for any real population. [Woodley and Read (1991) calculate a maximum growth rate of approximately 5% per year, but their argument for this being a maximum (i.e. that porpoise survival rates cannot exceed those of Himalayan thar) is not well justified.] Population growth rates have not actually been measured for any harbor porpoise population. Because a reliable estimate of the maximum net productivity rate is not available for Monterey Bay harbor porpoise, we use the default maximum net productivity rate (R_{MAX}) of 4% for cetaceans (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,143) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a species of unknown status; Wade and Angliss 1997), resulting in a PBR of 11.

HUMAN-CAUSED MORTALITY

Fishery Information

The incidental capture of harbor porpoise is largely limited to the halibut angel shark set gillnet fishery in Monterey Bay in central California (coastal setnets are not allowed in northern California, and harbor porpoise do not occur in southern California). Detailed information on this fishery is provided in Appendix 1. A summary of estimated fishery mortality and injury for this stock of harbor porpoise is given in Table 1. Mortality estimates for 1996-98 are based on total estimated fishing effort and prior-year entanglement rate data (Julian and Beeson 1998), because no observer program was in place during those years. Mortality estimates for 1999-2000 are based on a National Marine Fisheries Service monitoring program in Monterey Bay (Cameron and Forney 2000, Carretta 2001). Although mortality estimates for the most recent five years (1996-2000) are presented in Table 1, average annual takes in the setnet fishery are calculated using only 1999-2000 data, because these are the only recent years for which concurrent data on fishing effort and observed mortality from this region are available. An average of 79 harbor porpoise (CV= 0.29) were killed annually in this fishery in Monterey Bay during the years 1999-2000. Fishing effort in the Monterey fishery declined from 781 days fished in 1999 to 249 days in 2000. The lower effort in 2000 is attributable to an emergency closure issued in September 2000. Through the first three quarters of 2001, there were only 6 effort days recorded in the Monterey Bay fishery.

In September 2000, the California Department of Fish and Game (CDFG) issued emergency regulations which restricted fishing in the central California halibut set gillnet fishery to waters deeper than 60 fathoms, citing concerns over the continued mortality of common murres and decline of the southern sea otter population. The closure area extended from Point Reyes (N38) to Yankee Point (N36.5) in Monterey County and from Point Arguello (N34.6) to Point Sal (N34.9) in Santa Barbara County (the area from Yankee Point to Point Sal remained open to fishing outside of 30 fathoms). In April 2001, CDFG proposed permanent year-round regulations to eliminate set gillnet fishing inshore of 60 fathoms from Point Reyes to Point Arguello. The emergency closure inside of 60 fathoms has since lapsed and at least one vessel has resumed fishing outside of 30 fathoms in Monterey Bay. CDFG intends to make permanent a 60-fathom closure for the set gillnet fishery from Point Reyes to Point Arguello by May 2002.

Two harbor porpoise mortalities were inaccurately reported in Marine Mammal Authorization Permit (MMAP) fisher self-reports for the California drift gillnet fishery during 1996-98. Both of the mortalities occurred on an observed fishing trip and were actually short-beaked common dolphins (NMFS, Southwest Fisheries Science Center, unpublished data). This fishery has not previously been known to take harbor porpoise.

One fishery-related mortality stranding was reported in 1999 near Seaside, in Monterey Bay and two were reported in 2000, one from Ano Nuevo State Reserve and the other from Santa Cruz. These mortalities probably originate from the halibut set gillnet fishery in Monterey Bay. Based on experience with other fisheries (e.g. the set gillnet fishery), the proportion of incidentally killed animals that strand is generally only a fraction of the total mortality, and therefore these unidentified fisheries are likely to have taken more than the three observed harbor porpoise.

STATUS OF STOCK

Harbor porpoise in California are not listed as threatened or endangered under the Endangered Species Act nor as depleted under the Marine Mammal Protection Act. Barlow and Hanan (1995) calculate the status of harbor porpoise relative to historic carrying capacity (K) using a technique called back-projection. They calculate that the central California population could have been reduced to between 30% and 97% of K by incidental fishing mortality, depending on the choice of input parameters. They conclude that there is no practical way to reduce the range of this estimate. New information does not change this conclusion, and the status of harbor porpoise relative to their Optimum Sustainable Population (OSP) levels in central California must be treated as unknown. The average annual mortality for 1999-2000 (80 harbor porpoise) is greater than the calculated PBR (11) for Monterey Bay harbor porpoise; therefore, the Monterey Bay harbor porpoise population is "strategic" under the MMPA. The average gillnet mortality for 1999-2000 (79 porpoise per year) is greater than the calculated PBR; therefore, the fishery mortality cannot be considered insignificant and approaching zero mortality and serious injury rate. A 60 fathom emergency closure in this stocks range was in effect until May 2001, but these regulations have expired and have not as yet been renewed or made permanent. The CDFG intends on making a 60 fathom closure permanent by May 2002 from Point Reyes to Point Arguello. At least one vessel has resumed set gillnet fishing inside Monterey Bay inshore of 60 fathoms and others have relocated to Morro Bay (see Morro Bay stock assessment). The PBR for the Monterey Bay stock is only 11 animals, which is unlikely to be exceeded by one vessel, however, the potential for other vessels to return to the Monterey fishery remains and is cause for concern. Research activities will continue to monitor the population size and to investigate population trends. There are no known habitat issues that are of particular concern for this stock.

Table 1. Summary of available information on incidental mortality and injury of harbor porpoise (central CA stock 1996-98; Monterey Bay stock 1999-2000) in commercial fisheries that might take this species (Cameron and Forney 2000, Carretta 2001, Forney et al., 2001; NMFS/SWFSC, unpublished data). Mean annual takes are based on 1999-2000 data unless noted otherwise. n/a indicates that data are not available.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Kill/Day	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA angel shark / halibut and other species large mesh (>3.5") set gillnet fishery	1996	1990-94 observer data	0%	-	-	48 (0.19)	79 (0.29)[1]
	1997		0%	-	-	80 (0.19)	
	1998		0%	-	-	57 (0.19)	
	1999	observer data	23.0%	28[2]	0.17	133 (0.23)[2]	
	2000		27.0%	7	0.10	26 (0.50)	
Unknown fishery	1996-2000	Strandings	-	1 (in 1999) 2 (in 2000)		n/a	$\geq$ 0.6 (n/a)
Minimum total annual takes							80 (0.29)

[1]Only 1999-2000 mortality estimates are included in the average because these are the only recent years for which concurrent fishing effort and observed mortality data are available from this region (see text). Through the first 3 quarters of 2001, there were only 6 days of fishing effort reported by CDFG.

[2] This includes one unidentified cetacean that was almost certainly a harbor porpoise; without this animal the mortality estimate would be 128 (CV=0.23).

REFERENCES

Barlow, J. 1988. Harbor porpoise (*Phocoena phocoena*) abundance estimation in California, Oregon and Washington: I. Ship surveys. Fish. Bull. 86:417-432.

Barlow, J. and P. Boveng. 1991. Modeling age-specific mortality for marine mammal populations. Mar. Mamm. Sci. 7(1):84-119.

Barlow, J. and K. A. Forney. 1994. An assessment of the 1994 status of harbor porpoise in California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-205. 17 pp.

Barlow, J. and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. Rept. Int. Whal., Special Issue 16:123-140.

Calambokidis, J. and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. pp. 101-110 In: J. E. Reynolds III and D. K. Odell (eds.) Marine mammal strandings in the United States. NOAA Tech. Rep. NMFS 98.

Carretta, J.V. 2001. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2000. Paper SC/53/SM9 presented to the International Whaling Commission (unpublished). 21pp.

Carretta, J.V., Barlow, J., K.A. Forney, M.M. Muto, and J. Baker. 2001a. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Dep. Commer. NOAA Technical Memorandum NMFS-SWFSC-317. 280pp.

Carretta, J.V., B.L. Taylor, and S.J. Chivers. 2001b. Abundance and depth distribution of harbor porpoise (*Phocoena phocoena*) in northern California determined from a 1995 ship survey. U.S. Fishery Bulletin 99:29-39.

Chivers, S.J., A.E. Dizon, P.J. Gearin, and K.M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises, (Phocoena phocoena), indicated by molecular genetic analyses. Journal of Cetacean Research and Management 4(2):111-122.

Forney, K. A. 1999a. The abundance of California harbor porpoise estimated from 1993-97 aerial line-transect surveys. Admin. Rep. LJ-99-02. Southwest Fisheries Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 16 pp.

Forney, K. A. 1999b. Trends in harbor porpoise abundance off central California, 1986-95: Evidence for interannual changes in distribution? J. Cetacean Res. Manage. 1:73-80.

Gaskin, D. E. 1984. The harbour porpoise (*Phocoena phocoena* L.): regional populations, status, and information on direct and indirect catches. Rep. int. Whal. Commn 34:569-586.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and 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 prepared for the Pacific OCS Region.

Laake, J. L., J. C. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manag. 61:63-75.

NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-0271

NMFS, Southwest Region, 501 West Ocean Blvd, Long Beach, CA 90802-4213

Polacheck, T., F. W. Wenzel, and G. Early. 1995. What do stranding data say about harbor porpoise (*Phocoena phocoena*). Rep. Int. Whal. Comm., Special Issue 16:169-179.

Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, Univ. Calif. San Diego. 191pp.

Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, Phocoena phocoena, on inter-oceanic and regional scales. Can. J. Fish. and Aquat. Sci. 52:1210-1219.

Wade, P. R. and R. P. 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.

Woodley, T. H. and A. J. Read. 1991. Potential rates of increase of a harbour porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. Can. J. Fish. Aquat. Sci. 48:2429-2435.

Revised 10/31/2002 (new stock)

HARBOR PORPOISE (*Phocoena phocoena*): San Francisco-Russian River Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the Pacific, harbor porpoise are found in coastal and inland waters from Point Conception, California to Alaska and across to Kamchatka and Japan (Gaskin 1984). Harbor porpoise appear to have more restricted movements along the western coast of the continental U.S. than along the eastern coast. Regional differences in pollutant residues in harbor porpoise indicate that they do not move extensively between California, Oregon, and Washington (Calambokidis and Barlow 1991). That study also showed some regional differences within California (although the sample size was small). This pattern stands as a sharp contrast to the eastern coast of the U.S. and Canada where harbor porpoise are believed to migrate seasonally from as far south as the Carolinas to the Gulf of Maine and Bay of Fundy (Polacheck et al. 1995). A phylogeographic analysis of genetic data from northeast Pacific harbor porpoise did not show complete concordance between DNA sequence types and geographic location (Rosel 1992). However, an analysis of molecular variance (AMOVA) of the same data with additional samples found significant genetic differences for four of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (Rosel et al. 1995). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic or migratory, and movement is sufficiently restricted that genetic differences have evolved. Recent preliminary genetic analyses of samples ranging from Monterey Bay, California to Vancouver Island, British Columbia indicate that there is small-scale subdivision within the U.S. portion of this range (Chivers *et al.*, 2002).

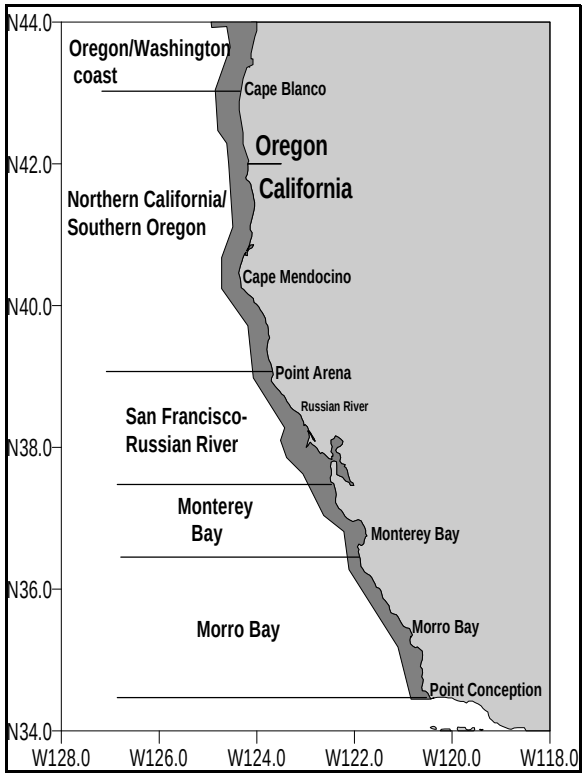

Figure 1. Stock boundaries and distributional range of harbor porpoise along the California/southern Oregon coast. Shaded area represents harbor porpoise habitat (0-200 m) along the U.S. west coast.

In their assessment of harbor porpoise, Barlow and Hanan (1995) recommended that the animals inhabiting central California (defined to be from Point Conception to the Russian River) be treated as a separate stock. Their justifications for this were: 1) fishery mortality of harbor porpoise is limited to central California, 2) movement of individual animals appears to be restricted within California, and consequently 3) fishery mortality could cause the local depletion of harbor porpoise if central California is not managed separately. Although geographic structure exists along an almost continuous distribution of harbor porpoise from California to Alaska, stock boundaries are difficult to draw because any rigid line is (to a greater or lesser extent) arbitrary from a biological perspective. Nonetheless, failure to recognize geographic structure by defining management stocks can lead to depletion of local populations. Based on recent genetic findings (Chivers *et al*., 2002), California coast stocks were re-evaluated and significant genetic differrences were found among 4 identified sampling sites. Revised stock boundaries are presented here based on these genetic data and density discontinuities identified from aerial surveys, resulting in six California/Oregon/Washington stocks where previously there had been four (Carretta *et al*. 2001a). The stock boundaries for animals that occur in California/southern Oregon waters are shown in Figure 1. For the 2002 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, other Pacific coast harbor porpoise stocks include: 1) a Morro Bay stock, 2) a Monterey Bay stock, 3) a northern California/southern Oregon stock, 4) an Oregon/Washington coast stock, 5) an Inland Washington stock, 6) a Southeast Alaska stock, 7) a Gulf of Alaska stock, and 8) a Bering Sea stock. Stock assessment reports for Morro

Bay, Monterey Bay, northern California/southern Oregon, Oregon/Washington coast, and Inland Washington waters harbor porpoise appear in this volume. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Previous estimates of abundance for California harbor porpoise were based on aerial surveys conducted between the coast and the 50-fm isobath during 1988-95 (Barlow and Forney 1994, Forney 1999a). These estimates did not include an unknown number of animals found in deeper waters. Barlow (1988) found that the vast majority of harbor porpoise in California were within the 0-50-fm depth range; however, Green et al. (1992) found that 24% of harbor porpoise seen during aerial surveys of Oregon and Washington were between the 100m and 200m isobaths (55 to 109 fathoms). A systematic ship survey of depth strata out to 90 m in northern California showed that porpoise abundance declined significantly in waters deeper than 60 m (Carretta *et al.* 2001b). A recent analysis of harbor porpoise trends including oceanographic data suggests that the proportion of California harbor porpoise in deeper waters may vary between years (Forney 1999b). In 1999, aerial surveys extended farther offshore (to the 200m depth contour or 15 nmi distance, whichever is farther) to provide a more complete abundance estimate. Although two harbor porpoise sightings were made in offshore waters under poor conditions (Beaufort sea state 3), only good conditions have traditionally been included in abundance analyses for this species (Barlow and Forney 1994, Forney 1999a), and therefore no offshore sightings contributed to the abundance estimate for this stock. Based on aerial surveys from 1997-99 under good survey conditions (Beaufort $\leq$ 2, cloud cover $\leq$ 25%) the estimate of abundance for this stock is 6,674 animals (CV = 0.39).

Minimum Population Estimate

The minimum population estimate for the San Francisco-Russian River harbor porpoise stock is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from the 1997-99 aerial surveys, or 4,858 animals.

Current Population Trend

Analyses of a 1986-95 time series of aerial surveys have been conducted to examine trends in harbor porpoise abundance in central California (Forney, 1995; 1999b). After controlling for the effects of sea state, cloud cover, and area on sighting rates, Forney (1995) found a negative trend in population size; however, that trend was no longer significant when sea surface temperature (a proxy measure of oceanographic conditions) was included in an updated non-linear trend analysis (Forney 1999b). The negative correlation between harbor porpoise sighting rates and sea surface temperatures indicates that apparent trends could be caused by changing oceanographic conditions and movement of animals into and out of the study area. Encounter rates for the 1997 survey, however, were very high (Forney 1999a) despite the warmer sea surface temperatures caused by strong El Niño conditions. These observations suggest that

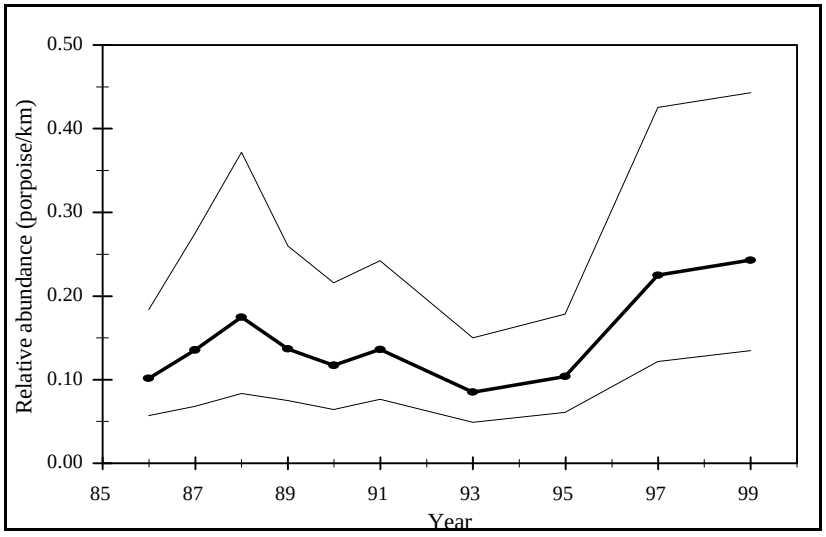

Figure 2. Relative abundance (+/- one standard error) of central California (Pt. Conception to Russian River) harbor porpoise, 1986-99, adjusted for sea state and cloud cover (following methods of Forney 1995). The trend shown includes the range of three California stocks (Morro Bay, Monterey Bay, and San Francisco-Russian River).

patterns of harbor porpoise movement are not directly related to sea surface temperature, but rather to the more complex distribution of potential prey species in this area. Although encounter rates during the 1999 aerial survey were again higher than in past years, the trend in relative abundance (following methods of Forney 1995) is not statistically significant (p=0.12, Figure 2). More detailed studies of encounter rate patterns in relation to satellite-derived sea surface temperature during 1993-99 are planned to shed light on potential oceanography-related movement patterns of harbor porpoise in this region.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (i.e. females give birth first at age 4 and produce one calf per year until death), the theoretical, maximum-conceivable growth rate of a closed harbor porpoise population was estimated as 9.4% per year (Barlow and Boveng 1991). This maximum theoretical rate may not be achievable for any real population. [Woodley and Read (1991) calculate a maximum growth rate of approximately 5% per year, but their argument for this being a maximum (i.e. that porpoise survival rates cannot exceed those of Himalayan thar) is not well justified.] Population growth rates have not actually been measured for any harbor porpoise population. Because a reliable estimate of the maximum net productivity rate is not available for northern California harbor porpoise, we use the default maximum net productivity rate (R_{MAX}) of 4% for cetaceans (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (4,858) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a species of unknown status; Wade and Angliss 1997), resulting in a PBR of 49.

HUMAN-CAUSED MORTALITY

Fishery Information

The incidental capture of harbor porpoise in California has largely been limited to set gillnet fisheries in Monterey Bay and to a lesser extent, Morro Bay. Coastal setnets are not allowed north of Bodega Head (to protect salmon resources there). However, in 1998, two harbor porpoise strandings near Bodega Head were attributed to fishery-related mortality, but the responsible fishery is unknown. Although the stranding location falls within the range of the San Francisco-Russian River harbor porpoise stock and this is probably the source stock for the mortalities, it is possible that these animals were taken from the northern California stock and subsequently drifted southward to the stranding location. Efforts are underway to identify fisheries that may have been responsible.

Table 1. Summary of available information on incidental mortality and injury of harbor porpoise (San Francisco-Russian River stock) in commercial fisheries that might take this species. Mean annual takes are based on 1996-2000 data unless noted otherwise. n/a indicates that data are not available.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Kill/Day	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
Unknown fishery	1996-2000	stranding	n/a	2 (in 1998)		n/a	$\geq$ 0.4 (n/a)
Minimum total annual takes							$\geq$ 0.4(n/a)

STATUS OF STOCK

Harbor porpoise in California are not listed as threatened or endangered under the Endangered Species Act nor as depleted under the Marine Mammal Protection Act. There are no known habitat issues that are of particular concern for this stock. The status of this stock relative to their Optimum Sustainable Population (OSP) is unknown, owing to historical fishery mortality of porpoise in this region (Barlow and Hanan 1995). Because the known human-caused mortality or serious injury (0.4 harbor porpoise per year) is less than the PBR (49), this stock is not considered a "strategic" stock under the MMPA. Because average annual fishery mortality is less than 10% of the PBR, the fishery mortality can be considered insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Barlow, J. 1988. Harbor porpoise (*Phocoena phocoena*) abundance estimation in California, Oregon and Washington: I. Ship surveys. Fish. Bull. 86:417-432.

Barlow, J. and P. Boveng. 1991. Modeling age-specific mortality for marine mammal populations. Mar. Mamm. Sci. 7(1):84-119.

Barlow, J. and K. A. Forney. 1994. An assessment of the 1994 status of harbor porpoise in California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-205. 17 pp.

Barlow, J. and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. Rept. Int. Whal., Special Issue 16:123-140.

Calambokidis, J. and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. pp. 101-110 In: J. E. Reynolds III and D. K. Odell (eds.) Marine mammal strandings in the United States. NOAA Tech. Rep. NMFS 98.

Carretta, J.V., J. Barlow, K.A. Forney, M.M. Muto, and J. Baker. 2001a. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Dep. Commer. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-317. 280 p.

Carretta, J.V., B.L. Taylor, and S.J. Chivers. 2001b. Abundance and depth distribution of harbor porpoise (*Phocoena phocoena*) in northern California determined from a 1995 ship survey. U.S. Fishery Bulletin 99:29-39.

Chivers, S.J., A.E. Dizon, P.J. Gearin, and K.M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises, (Phocoena phocoena), indicated by molecular genetic analyses. Journal of Cetacean Research and Management 4(2):111-122.

Forney, K. A. 1999a. The abundance of California harbor porpoise estimated from 1993-97 aerial line-transect surveys. Admin. Rep. LJ-99-02. Southwest Fisheries Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 16 pp.

Forney, K. A. 1999b. Trends in harbor porpoise abundance off central California, 1986-95: Evidence for interannual changes in distribution? J. Cetacean Res. Manage. 1:73-80.

Gaskin, D. E. 1984. The harbour porpoise (*Phocoena phocoena* L.): regional populations, status, and information on direct and indirect catches. Rep. int. Whal. Commn 34:569-586.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and 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 prepared for the Pacific OCS Region.

Laake, J. L., J. C. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manag. 61:63-75.

NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-0271

NMFS, Southwest Region, 501 West Ocean Blvd, Long Beach, CA 90802-4213

Polacheck, T., F. W. Wenzel, and G. Early. 1995. What do stranding data say about harbor porpoise (*Phocoena phocoena*). Rep. Int. Whal. Comm., Special Issue 16:169-179.

Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, Univ. Calif. San Diego. 191pp.

Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, Phocoena phocoena, on inter-oceanic and regional scales. Can. J. Fish. and Aquat. Sci. 52:1210-1219.

Wade, P. R. and R. P. 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.

Woodley, T. H. and A. J. Read. 1991. Potential rates of increase of a harbour porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. Can. J. Fish. Aquat. Sci. 48:2429-2435.

Revised 10/31/2002

HARBOR PORPOISE (*Phocoena phocoena*): Northern California/Southern Oregon Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the Pacific, harbor porpoise are found in coastal and inland waters from Point Conception, California to Alaska and across to Kamchatka and Japan (Gaskin 1984). Harbor porpoise appear to have more restricted movements along the western coast of the continental U.S. than along the eastern coast. Regional differences in pollutant residues in harbor porpoise indicate that they do not move extensively between California, Oregon, and Washington (Calambokidis and Barlow 1991). That study also showed some regional differences within California (although the sample size was small). This pattern stands as a sharp contrast to the eastern coast of the U.S. and Canada where harbor porpoise are believed to migrate seasonally from as far south as the Carolinas to the Gulf of Maine and Bay of Fundy (Polacheck et al. 1995). A phylogeographic analysis of genetic data from northeast Pacific harbor porpoise did not show complete concordance between DNA sequence types and geographic location (Rosel 1992). However, an analysis of molecular variance (AMOVA) of the same data with additional samples found significant genetic differences for four of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (Rosel et al. 1995). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic or migratory, and movement is sufficiently restricted that genetic differences have evolved. Recent preliminary genetic analyses of samples ranging from Monterey Bay, California to Vancouver Island, British Columbia indicate that there is small-scale subdivision within the U.S. portion of this range Chivers *et al.*, 2002).

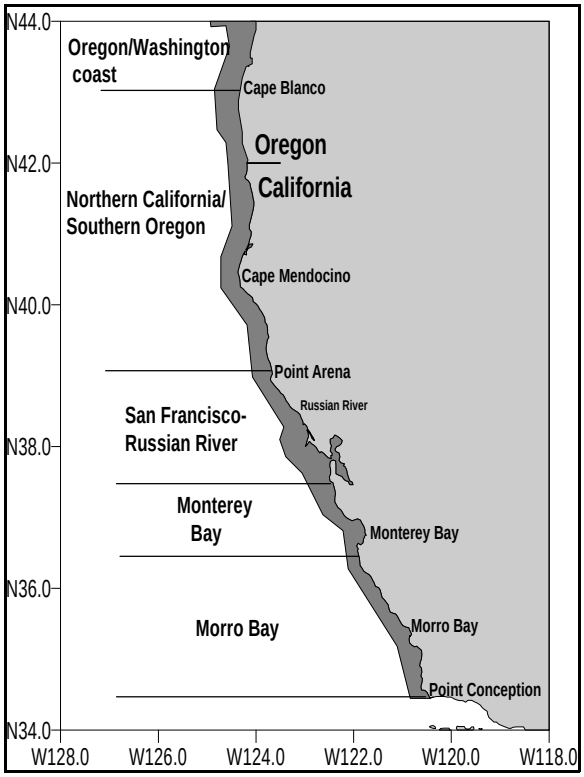

Figure 1. Stock boundaries and distributional range of harbor porpoise along the California/southern Oregon coast. Shaded area represents harbor porpoise habitat (0-200 m) along the U.S. west coast.

In their assessment of harbor porpoise, Barlow and Hanan (1995) recommended that the animals inhabiting central California (defined to be from Point Conception to the Russian River) be treated as a separate stock. Their justifications for this were: 1) fishery mortality of harbor porpoise is limited to central California, 2) movement of individual animals appears to be restricted within California, and consequently 3) fishery mortality could cause the local depletion of harbor porpoise if central California is not managed separately. Although geographic structure exists along an almost continuous distribution of harbor porpoise from California to Alaska, stock boundaries are difficult to draw because any rigid line is (to a greater or lesser extent) arbitrary from a biological perspective. Nonetheless, failure to recognize geographic structure by defining management stocks can lead to depletion of local populations. Based on recent genetic findings (Chivers *et al*., 2002), California coast stocks were re-evaluated and significant genetic differences were found among 4 identified sampling sites. Revised stock boundaries are presented here based on these genetic data and density discontinuities identified from aerial surveys, resulting in six west coast stocks where previously there had been four (Carretta *et al*. 2001a). These new stock boundaries are shown in Figure 1. For the 2002 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, other Pacific coast harbor porpoise stocks include: 1) a Morro Bay stock, 2) a Monterey Bay stock, 3) a San Francisco-Russian River stock, 4) an Oregon/Washington coast stock, 5) an Inland Washington stock, 6) a Southeast Alaska stock, 7) a Gulf of Alaska stock, and 8) a Bering Sea stock. The stock assessment reports for Morro Bay, Monterey Bay, and San Francisco-Russian River, harbor porpoise

appear in this volume. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Previous estimates of abundance for California harbor porpoise were based on aerial surveys conducted between the coast and the 50-fm isobath during 1988-95 (Barlow and Forney 1994, Forney 1999a). These estimates did not include an unknown number of animals found in deeper waters. Barlow (1988) found that the vast majority of harbor porpoise in California were within the 0-50-fm depth range; however, Green et al. (1992) found that 24% of harbor porpoise seen during aerial surveys of Oregon and Washington were between the 100m and 200m isobaths (55 to 109 fathoms). A systematic ship survey of depth strata out to 90 m in northern California showed that porpoise abundance declined significantly in waters deeper than 60 m (Carretta et al. 2001b). A recent analysis of harbor porpoise trends including oceanographic data suggests that the proportion of California harbor porpoise in deeper waters may vary between years (Forney 1999b; see Current Population Trend below). In 1999, aerial surveys extended farther offshore (to the 200m depth contour or 15 nmi distance, whichever is farther) to provide a more complete abundance estimate. Based on pooled 1997-99 aerial survey data including data from both inshore and offshore areas, an updated estimate of abundance for the northern California/southern Oregon harbor porpoise stock is 17,763 harbor porpoise (CV=0.39). Approximately 1,572 (CV=0.86) porpoise were estimated in the northern California offshore stratum (SWFSC, unpublished data); 11,135 (CV= 0.38) in the northern California inshore stratum (SWFSC, unpublished data); 4,808 (CV = 0.49) from southern Oregon Area VI (Laake et al. 1998), and 250 (CV = 1.09) animals from southern Oregon Area VIF (Laake et al. 1998).

Minimum Population Estimate

The minimum population estimate for harbor porpoise in northern California/southern Oregon is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from 1997-99 aerial surveys in northern California and 1997 aerial surveys in southern Oregon, or 12,940 animals. This estimate includes harbor porpoise within an area extending to the 200m isobath or 15 nmi, whichever is farther from shore.

Current Population Trend

Forney (1999b) examines trends in relative harbor porpoise abundance in central and northern California based on aerial surveys from 1989-95. No significant trends were evident over this time period for the Northern California Stock. The 1997-99 survey results continue to show no trend in relative abundance (Figure 2).

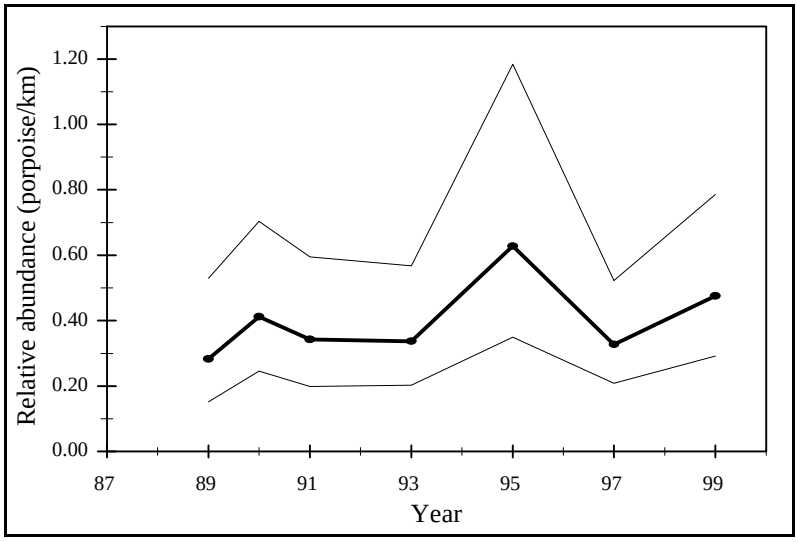

Figure 2. Relative abundance (+/- one standard error) or northern California (Russian River to CA/OR border) harbor porpoise, 1989-99, adjusted for sea state and cloud cover (following methods of Forney 1995).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (i.e. females give birth first at age 4 and produce one calf per year until death), the theoretical, maximum-conceivable growth rate of a closed harbor porpoise population was estimated as 9.4% per year (Barlow and Boveng 1991). This maximum theoretical rate may not be achievable for any real population. [Woodley and Read (1991) calculate a maximum growth rate of approximately 5% per year, but their argument for this being a maximum (i.e. that porpoise survival rates cannot exceed those of Himalayan thar) is not

well justified.] Population growth rates have not actually been measured for any harbor porpoise population. Because a reliable estimate of the maximum net productivity rate is not available for northern California harbor porpoise, we use the default maximum net productivity rate (R_{MAX}) of 4% for cetaceans (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (12,940) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 1.0 (for a species within its Optimal Sustainable Population; Wade and Angliss 1997), resulting in a PBR of 259.

HUMAN-CAUSED MORTALITY

Fishery Information

The incidental capture of harbor porpoise in California is largely limited to set gillnet fisheries in central California. Coastal setnets are not allowed in northern California (to protect salmon resources there). However, one harbor porpoise mortality was documented for the Klamath River tribal salmon gillnet fishery in 1995 (NMFS, Southwest Region, unpublished data). There have been no observed harbor porpoise mortalities or fishery-related strandings in the Klamath River tribal salmon gillnet fishery for the most recent five-year period (1996-2000) (pers. comm., Kathleen Williamson, Yurok tribe biologist).

Table 1. Summary of available information on incidental mortality and injury of harbor porpoise (northern CA stock) in fisheries that might take this species. n/a indicates that data are not available.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA Klamath River tribal salmon gillnet fishery	1996-2000	Observation	n/a	0	≥ 0	≥ 0
Minimum total annual takes						≥ 0

STATUS OF STOCK

Harbor porpoise in northern California/southern Oregon are not listed as threatened or endangered under the Endangered Species Act nor as depleted under the Marine Mammal Protection Act. There are no known habitat issues that are of particular concern for this stock. Because of the lack of recent or historical sources of human-caused mortality, the harbor porpoise stock in northern California has been concluded to be within their Optimum Sustainable Population (OSP) level (Barlow and Forney 1994). Because the known human-caused mortality or serious injury (≥ 0 harbor porpoise per year) is less than the PBR (259), this stock is not considered a "strategic" stock under the MMPA. Because average annual fishery mortality is less than 10% of the PBR, the fishery mortality can be considered insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Barlow, J. 1988. Harbor porpoise (*Phocoena phocoena*) abundance estimation in California, Oregon and Washington: I. Ship surveys. Fish. Bull. 86:417-432.

Barlow, J. and P. Boveng. 1991. Modeling age-specific mortality for marine mammal populations. Mar. Mamm. Sci. 7(1):84-119.

Barlow, J. and K. A. Forney. 1994. An assessment of the 1994 status of harbor porpoise in California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-205. 17 pp.

Barlow, J. and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. Rept. Int. Whal., Special Issue 16:123-140.

Carretta, J.V. J. Barlow, K.A. Forney, M.M. Muto, and J. Baker. 2001a. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Dep. Commer. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-317. 280p.

Carretta, J.V., B.L. Taylor, and S.J. Chivers. 2001b. Abundance and depth distribution of harbor porpoise (*Phocoena*

phocoena) in northern California determined from a 1995 ship survey. U.S. Fishery Bulletin 99:29-39.
Calambokidis, J. and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. pp. 101-110 In: J. E. Reynolds III and D. K. Odell (eds.) Marine mammal strandings in the United States. NOAA Tech. Rep. NMFS 98.
Chivers, S.J., A.E. Dizon, P.J. Gearin, and K.M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises, (Phocoena phocoena), indicated by molecular genetic analyses. Journal of Cetacean Research and Management 4(2):111-122.
Forney, K. A. 1999a. The abundance of California harbor porpoise estimated from 1993-97 aerial line-transect surveys. Admin. Rep. LJ-99-02. Southwest Fisheries Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 16 pp.
Forney, K. A. 1999b. Trends in harbor porpoise abundance off central California, 1986-95: Evidence for interannual changes in distribution? J. Cetacean Res. Manage. 1:73-80.
Gaskin, D. E. 1984. The harbour porpoise (*Phocoena phocoena* L.): regional populations, status, and information on direct and indirect catches. Rep. int. Whal. Commn 34:569-586.
Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and 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 prepared for the Pacific OCS Region.
Laake, J. L., J. C. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manag. 61:63-75.
Laake, J., J. Calambokidis, S. Osmek. 1998. Survey report for the 1997 aerial surveys for harbor porpoise and other marine mammals of Oregon, Washington, and British Columbia outside waters. Alaska Fisheries Science Center Processed Report 98-10. pp. 77-97.
NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-0271
NMFS, Southwest Region, 501 West Ocean Blvd, Long Beach, CA 90802-4213
Polacheck, T., F. W. Wenzel, and G. Early. 1995. What do stranding data say about harbor porpoise (*Phocoena phocoena*). Rep. Int. Whal. Comm., Special Issue 16:169-179.
Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, Univ. Calif. San Diego. 191pp.
Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, Phocoena phocoena, on inter-oceanic and regional scales. Can. J. Fish. and Aquat. Sci. 52:1210-1219.
Wade, P. R. and R. P. 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.
Woodley, T. H. and A. J. Read. 1991. Potential rates of increase of a harbour porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. Can. J. Fish. Aquat. Sci. 48:2429-2435.

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HARBOR PORPOISE (*Phocoena phocoena*): Oregon/Washington Coast Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the eastern North Pacific Ocean, the harbor porpoise ranges from Point Barrow, along the Alaskan coast, and down the west coast of North America to Point Conception, California (Gaskin 1984). Harbor porpoise primarily frequent coastal waters. Harbor porpoise are known to occur year-round in the inland trans-boundary area of Washington and British Columbia, Canada (Osborne et al. 1988), and along the Oregon/Washington coast (Barlow 1988, Barlow et al. 1988, Green et al. 1992). Aerial survey data from coastal Oregon and Washington, collected during all seasons, suggests that harbor porpoise distribution varies by depth (Green et al. 1992). Although distinct seasonal changes in abundance along the west coast have been noted, and attributed to possible shifts in distribution to deeper offshore waters during late winter (Dohl et al. 1983, Barlow 1988), harbor porpoise have also been conspicuously absent in offshore areas in late November (B. Taylor, pers. comm.) leaving a gap in the current understanding of their movements.

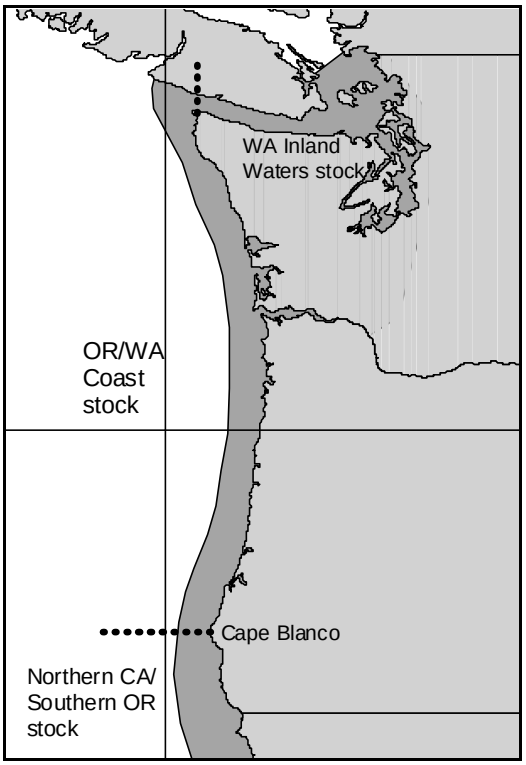

Figure 1. Approximate distribution of harbor porpoise in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the stocks are shown.

Stock discreteness in the eastern North Pacific was analyzed using mitochondrial DNA from samples collected along the west coast (Rosel 1992) and is summarized in Osmek et al. (1994). Two distinct mtDNA groupings or clades exist. One clade is present in California, Washington, British Columbia, and Alaska (no samples were available from Oregon), while the other is found only in California and Washington. Although these two clades are not geographically distinct by latitude, the results may indicate a low mixing rate for harbor porpoise along the west coast of North America. Investigation of pollutant loads in harbor porpoise ranging from California to the Canadian border also suggests restricted harbor porpoise movements (Calambokidis and Barlow 1991). Further genetic testing of the same data mentioned above, along with additional samples, found significant genetic differences for four of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (Rosel et al. 1995). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic or migratory, and that movement is sufficiently restricted to evolve genetic differences. This is consistent with low movement suggested by genetic analysis of harbor porpoise specimens from the North Atlantic, where numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles.

Using the 1990-91 aerial survey data of Calambokidis et al. (1993) for water depths < 50 fathoms, Osmek et al. (1996) found significant differences in harbor porpoise mean densities ($z=5.9$, $p<0.01$) between the waters of coastal Oregon/Washington and inland Washington/southern British Columbia, Canada (i.e., Strait of Juan de Fuca/San Juan Islands). Although differences in density exist between coastal Oregon/Washington and inland Washington, a specific stock boundary line cannot be identified based upon biological or genetic differences. However, because harbor porpoise movements and rates of intermixing within the northeast Pacific are restricted, there has been a significant decline in harbor porpoise sightings within southern Puget Sound since the 1940s and, following a risk averse management strategy, two stocks are recognized: the Oregon/Washington Coast stock (between Cape Blanco, OR, and Cape Flattery, WA) and the Washington Inland Waters stock (in waters east of Cape Flattery) (see Fig. 1). Recent genetic evidence suggests that the population of eastern North Pacific harbor porpoise is more finely structured than is currently recognized (Chivers et al. 2002). All relevant data (e.g., genetic samples, contaminant studies, and satellite tagging) will be reviewed to determine whether to adjust the stock boundaries for harbor porpoise in Oregon and

Washington waters.

In their assessment of California harbor porpoise, Barlow and Hanan (1995) recommended two stocks be recognized in California, with the stock boundary at the Russian River. Based on recent genetic findings (Chivers et al. 2002), California coast stocks were re-evaluated and significant genetic differences were found among four identified sampling sites. Revised stock boundaries based on these genetic data and density discontinuities identified from aerial surveys resulted in six California/Oregon/Washington stocks where previously there had been four (Carretta et al. 2001): 1) the Washington Inland Waters stock, 2) the Oregon/Washington Coast stock, 3) the Northern California/Southern Oregon stock, 4) the San Francisco-Russian River stock, 5) the Monterey Bay stock, and 6) the Morro Bay stock. This report considers only the Oregon/Washington Coast stock. Stock assessment reports for the Washington Inland Waters, Northern California/Southern Oregon, San Francisco-Russian River, Monterey Bay, and Morro Bay harbor porpoise stocks appear in this volume. Three harbor porpoise stocks are also recognized in the inland and coastal waters of Alaska, including the Southeast Alaska, Gulf of Alaska, and Bering Sea stocks. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region. The harbor porpoise occurring in British Columbia have not been included in any stock assessment report from either the Alaska Region or Pacific Northwest (Oregon/Washington).

POPULATION SIZE

In August and September 1997, an aerial survey of Oregon, Washington, and southern British Columbia coastal waters, from shore to 200 m depth, resulted in an observed abundance of 11,599 (CV=0.115) harbor porpoise in U.S. waters north of Cape Blanco, OR (Laake et al. 1998a). Using a correction factor of 3.42 (1/g(0); g(0)=0.292, CV=0.366) to adjust for groups missed by aerial observers, the corrected estimate of abundance for harbor porpoise in coastal Oregon (north of Cape Blanco) and Washington waters is 39,586 (CV=0.384). This estimate represents a substantial increase over the 1991 estimate of 26,175 (Osmek et al. 1996), even though it excludes the area south of Cape Blanco, due to: 1) the larger sampling region in the 1997 survey (out to water depths of 200 m vs. 91 m in 1991), and 2) a different estimate of g(0) (Laake et al. 1998a).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 39,586 and its associated CV(N) of 0.384, N_{MIN} for the Oregon/Washington Coast stock of harbor porpoise is 28,967.

Current Population Trend

There are no reliable data on population trends of harbor porpoise for coastal Oregon, Washington, or British Columbia waters.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently not available for harbor porpoise. Therefore, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% (Wade and Angliss 1997) be employed for the Oregon/Washington Coast harbor porpoise stock.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (28,967) times one-half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a stock of unknown status, Wade and Angliss 1997), resulting in a PBR of 290 harbor porpoise per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Within the EEZ boundaries of coastal Oregon and Washington, human-caused (fishery) mortalities of harbor porpoise are presently known to occur only in the northern Washington marine set gillnet fishery. During 1992-1993 the WA/OR Lower Columbia River, WA Grays Harbor, and WA Willapa Bay drift gillnet fisheries were monitored at observer coverages of approximately 4% and 2%, respectively. There were no observed harbor porpoise mortalities

in these fisheries.

NMFS observers monitored the northern Washington marine set gillnet fishery during 1994-1998 and in 2000; there was no observer coverage in 1999, however, the total fishing effort was only 4 net days in inland waters (Gearin et al. 1994, 2000; P. Gearin, unpubl. data). For the entire area fished (coastal + inland waters), observer coverage ranged from approximately 33 to 98% during observed years. Fishing effort is conducted within the range of both harbor porpoise stocks (Oregon/Washington Coast and Washington Inland Waters stocks) occurring in Washington State waters. For the purposes of this stock assessment report, the animals taken in the inland portion of the fishery are assumed to have belonged to the Washington Inland Waters stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon/Washington Coast stock. Some movement of harbor porpoise between Washington's coastal and inland waters is likely, but it is currently not possible to quantify the extent of such movements. Accordingly, Table 1 includes data only from that portion of the northern Washington marine set gillnet fishery occurring within the range of the Oregon/Washington Coast stock (those waters south and west of Cape Flattery, WA, and north of Cape Blanco, OR), where observer coverage was 30% in 1994 and 100% in 1995-1997 and 2000. In 1994, the observer program was delayed because the biological opinion on the fishery, relating to takes of marbled murrelets under the ESA, was not completed by the time the fishery began. One vessel fished in the coastal fishery in 1994 and 30% of the sets were observed. Although no harbor porpoise mortalities were observed, the vessel operator reported 9 mortalities to NMFS during the season (5 before the observer program began and 4 after it ended). No fishing effort occurred in the coastal portion of the fishery in 1998 or 1999. Data from 1994 to 2000 are included in Table 1, although the mean estimated annual mortality is calculated using the most recent 5 years of available data. The mean estimated mortality for this fishery is 9 (CV= 0.62) harbor porpoise per year from this stock.

Table 1. Summary of incidental mortality of harbor porpoise (Oregon/Washington Coast stock) in commercial and tribal fisheries and calculation of the mean annual mortality rate; n/a indicates that data are not available. Mean annual takes are based on 1996-2000 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery: coastal waters)	94	obs data	30%	0	0	9 (0.62)
	95		100%	20	20	
	96		100%	29	29	
	97		100%	13	13	
	98		no fishery	0	0	
	99		no fishery	0	0	
	00		100%	3	3	
	94-00	self reports		9, 0, 0, 0, 0, 0, 0		0
Estimated total annual takes						9 (0.62)

The 1995-1997 data for the northern Washington marine set gillnet fishery were collected as part of an experiment, conducted in cooperation with the Makah Tribe, designed to explore the merits of using acoustic alarms to reduce bycatch of harbor porpoise in salmon gillnets. Results in 1995-1996 indicated that the nets equipped with acoustic alarms had significantly lower entanglement rates, as only 2 of the 49 mortalities occurred in alarmed nets (Gearin et al. 1996, 2000; Laake et al. 1997). Harbor porpoise were displaced by an acoustic buffer around the net, but it is unclear whether the porpoise were repelled by the alarms or whether it was their prey that were repelled (Kraus et al. 1997, Laake et al. 1998b). Because this fishery is likely to have acoustic devices on all nets in the future, the mean mortality estimated from non-alarmed nets may not be applicable. In 1997, 13 mortalities were observed (100% observer coverage) in this fishery and 96% of the sets were equipped with acoustic alarms (Gearin et al. 2000; P. Gearin, unpubl. data).

An additional source of information on the number of harbor porpoise killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1994 and 2000, there were no fisher self-reports of harbor porpoise mortalities from any fisheries operating within the range of the Oregon/Washington Coast stock. However, because logbook records (fisher

self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-1995 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 in Angliss et al. 2001 for details).

There have been no fishery-related strandings of harbor porpoise from this stock dating back to at least 1990.

Other Mortality

According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region, no human-caused harbor porpoise mortalities or serious injuries were reported from non-fisheries sources in 1996-2000.

STATUS OF STOCK

Harbor porpoise are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on the currently available data, the level of human-caused mortality and serious injury (9) does not exceed the PBR (290). Therefore, the Oregon/Washington Coast stock of harbor porpoise is not classified as "strategic." The total fishery mortality and serious injury for this stock (9: based on observer data) is not known to exceed 10% of the calculated PBR (29) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The status of this stock relative to its Optimum Sustainable Population (OSP) level and population trends is unknown.

REFERENCES

Angliss, R.P., D.P. DeMaster, and A.L. Lopez. 2001. Alaska marine mammal stock assessments, 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-124. 203 pp.

Barlow, J. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: I. Ship surveys. Fish. Bull. 86:417-432.

Barlow, J., and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. Rep. Int. Whal. Commn. Special Issue 16:123-140.

Barlow, J., C. W. Oliver, T. D. Jackson, and B. L. Taylor. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial Surveys. Fish. Bull. 86:433-444.

Calambokidis, J., and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. Reynolds, J. E., III, and D. K. Odell (eds.), Proceedings of the second marine mammal stranding workshop: 3-5 December 1987, Miami, Florida. NMFS, NOAA Tech. Rep. NMFS 98:101-110.

Calambokidis, J., J. C. Cubbage, J. R. Evenson, S. D. Osmek, J. L. Laake, P. J. Gearin, B. J. Turnock, S. J. Jeffries, and R. F. Brown. 1993. Abundance estimates of harbor porpoise in Washington and Oregon waters. Final Report by Cascadia Research, Olympia, WA, to National Marine Mammal Laboratory, AFSC, NMFS, Seattle, WA. 55 pp.

Carretta, J. V., J. Barlow, K. A. Forney, M. M. Muto, and J. Baker. 2001. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-317. 280 pp.

Chivers, S. J., A. E. Dizon, P. J. Gearin, and K. M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises (*Phocoena phocoena*) indicated by molecular genetic analyses. J. Cetacean Res. Manage. 4(2):111-122.

Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-1983: status, abundance, and distribution. OCS Study MMS 84-0045. Pacific OCS Region Minerals Management Service, 1340 Sixth Street, Los Angeles, CA 90014. 284 pp.

Gaskin, D. E. 1984. The harbour porpoise *Phocoena phocoena* (L.): regional populations, status, and information on direct and indirect catches. Rep. Int. Whal. Commn. 34:569-586.

Gearin, P. J. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.
Gearin, P. J., S. R. Melin, R. L. DeLong, H. Kajimura, and M. A. Johnson. 1994. Harbor porpoise interactions with a chinook salmon set-net fishery in Washington State. Rep. Int. Whal. Commn. Special Issue 15:427-438.
Gearin, P. J., M. E. Gosho, L. Cooke, R. DeLong, and J. Laake. 1996. Acoustic alarm experiment in the 1995 northern Washington marine setnet fishery: methods to reduce by-catch of harbor porpoise. Paper SC/48/SM10 presented to the International Whaling Commission, June 1996 (unpublished). 15 pp.
Gearin, P. J., M. E. Gosho, J. L. Laake, L. Cooke, R. L. DeLong, and K. M. Hughes. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the state of Washington. J. Cetacean Res. Manage. 2(1):1-9.
Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnel, and K. C. Balcomb. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Ch. 1, *In:* Brueggeman, J. J. (ed.), Oregon and Washington marine mammal and seabird surveys. Final Rep. OCS Study MMS 91-0093.
Kraus, S. D., A. J. Read, A. Solow, K. Baldwin, T. Spradlin, E. Anderson, and J. Williamson. 1997. Acoustic alarms reduce porpoise mortality. Nature 388:525.
Laake, J. L., P. J. Gearin, M. E. Gosho, and R. L. DeLong. 1997. Evaluation of effectiveness of pingers to reduce incidental entanglement of harbor porpoise in a set gillnet fishery. Pp. 75-81, *In:* Hill, P. S., and D. P. DeMaster (eds.), MMPA and ESA Implementation Program, 1996. AFSC Processed Report 97-10. 255 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
Laake, J., J. Calambokidis, and S. Osmek. 1998a. Survey report for the 1997 aerial surveys for harbor porpoise and other marine mammals of Oregon, Washington and British Columbia outside waters. Pp. 77-97, *In:* Hill, P. S., and D. P. DeMaster (eds.), MMPA and ESA Implementation Program, 1997. AFSC Processed Report 98-10. 246 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
Laake, J. L., D. J. Rugh, and L. S. Baraff. 1998b. Observations of harbor porpoise in the vicinity of acoustic alarms on a set gillnet. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-84. 40 pp.
Osborne, R., J. Calambokidis, and E. M. Dorsey. 1988. A Guide to Marine Mammals of Greater Puget Sound. Island Publishers, Anacortes, WA. 191 pp.
Osmek, S. D., P. E. Rosel, A. E. Dizon, and R. L. DeLong. 1994. Harbor porpoise, *Phocoena phocoena*, population assessment in Oregon and Washington, 1993. 1993 Annual Report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 14 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
Osmek, S., J. Calambokidis, J. Laake, P. Gearin, R. DeLong, J. Scordino, S. Jeffries, and R. Brown. 1996. Assessment of the status of harbor porpoise, *Phocoena phocoena*, in Oregon and Washington waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-76. 46 pp.
Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Thesis, Univ. Calif. San Diego, La Jolla, CA. 191 pp.
Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, *Phocoena phocoena*, on inter-oceanic and regional scales. Can. J. Fish. and Aquat. Sci. 52:1210-1219.
Taylor, B. L. Southwest Fisheries Science Center, NMFS, P.O. Box 271, La Jolla, CA 92038.
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.

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HARBOR PORPOISE (*Phocoena phocoena*): Washington Inland Waters Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the eastern North Pacific Ocean, the harbor porpoise ranges from Point Barrow, along the Alaskan coast, and down the west coast of North America to Point Conception, California (Gaskin 1984). Harbor porpoise primarily frequent coastal waters. Harbor porpoise are known to occur year-round in the inland trans-boundary area of Washington and British Columbia, Canada (Osborne et al. 1988), and along the Oregon/Washington coast (Barlow 1988, Barlow et al. 1988, Green et al. 1992). Aerial survey data from coastal Oregon and Washington, collected during all seasons, suggests that harbor porpoise distribution varies by depth (Green et al. 1992). Although distinct seasonal changes in abundance along the west coast have been noted, and attributed to possible shifts in distribution to deeper offshore waters during late winter (Dohl et al. 1983, Barlow 1988), harbor porpoise have also been conspicuously absent in offshore areas in late November (B. Taylor, pers. comm.) leaving a gap in the current understanding of their movements.

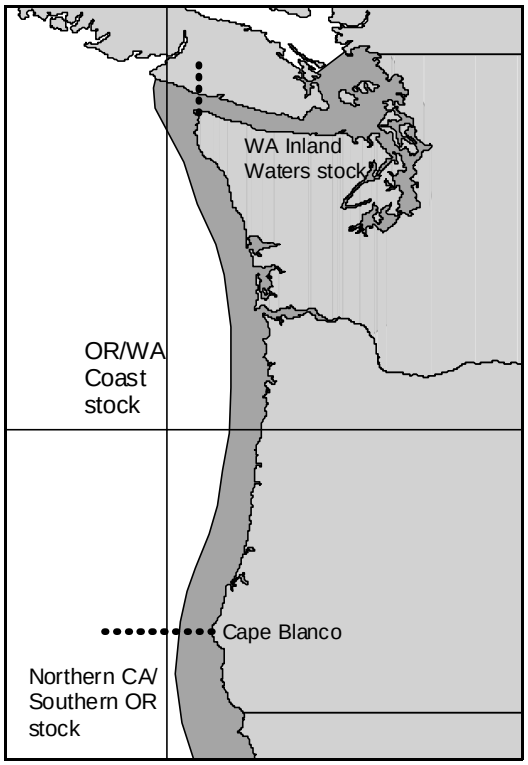

Figure 1. Approximate distribution of harbor porpoise in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the stocks are shown.

Stock discreteness in the eastern North Pacific was analyzed using mitochondrial DNA from samples collected along the west coast (Rosel 1992) and is summarized in Osmek et al. (1994). Two distinct mtDNA groupings or clades exist. One clade is present in California, Washington, British Columbia, and Alaska (no samples were available from Oregon), while the other is found only in California and Washington. Although these two clades are not geographically distinct by latitude, the results may indicate a low mixing rate for harbor porpoise along the west coast of North America. Investigation of pollutant loads in harbor porpoise ranging from California to the Canadian border also suggests restricted harbor porpoise movements (Calambokidis and Barlow 1991). Further genetic testing of the same data mentioned above, along with additional samples, found significant genetic differences for four of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (Rosel et al. 1995). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic or migratory, and that movement is sufficiently restricted to evolve genetic differences. This is consistent with low movement suggested by genetic analysis of harbor porpoise specimens from the North Atlantic, where numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles.

Using the 1990-1991 aerial survey data of Calambokidis et al. (1993) for water depths < 50 fathoms, Osmek et al. (1996) found significant differences in harbor porpoise mean densities ($z=5.9$, $p<0.01$) between the waters of coastal Oregon/Washington and inland Washington/southern British Columbia, Canada (i.e., Strait of Juan de Fuca/San Juan Islands). Although differences in density exist between coastal Oregon/Washington and inland Washington, a specific stock boundary line cannot be identified based upon biological or genetic differences. However, because harbor porpoise movements and rates of intermixing within the northeast Pacific are restricted, there has been a significant decline in harbor porpoise sightings within southern Puget Sound since the 1940s and, following a risk averse management strategy, two stocks are recognized: the Oregon/Washington Coast stock (between Cape Blanco, OR, and Cape Flattery, WA) and the Washington Inland Waters stock (in waters east of Cape Flattery) (see Fig. 1). Recent genetic evidence suggests that the population of eastern North Pacific harbor porpoise is more finely structured than is currently recognized (Chivers et al. 2002). All relevant data (e.g., genetic samples, contaminant studies, and satellite tagging) will be reviewed to determine whether to adjust the stock boundaries for harbor porpoise in Oregon and

Washington waters.

In their assessment of California harbor porpoise, Barlow and Hanan (1995) recommended two stocks be recognized in California, with the stock boundary at the Russian River. Based on recent genetic findings (Chivers et al. 2002), California coast stocks were re-evaluated and significant genetic differences were found among four identified sampling sites. Revised stock boundaries based on these genetic data and density discontinuities identified from aerial surveys resulted in six California/Oregon/Washington stocks where previously there had been four (Carretta et al. 2001): 1) the Washington Inland Waters stock, 2) the Oregon/Washington Coast stock, 3) the Northern California/Southern Oregon stock, 4) the San Francisco-Russian River stock, 5) the Monterey Bay stock, and 6) the Morro Bay stock. This report considers only the Washington Inland Waters stock. Stock assessment reports for the Oregon/Washington Coast, Northern California/Southern Oregon, San Francisco-Russian River, Monterey Bay, and Morro Bay harbor porpoise stocks appear in this volume. Three harbor porpoise stocks are also recognized in the inland and coastal waters of Alaska, including the Southeast Alaska, Gulf of Alaska, and Bering Sea stocks. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region. The harbor porpoise occurring in British Columbia have not been included in any stock assessment report from either the Alaska Region or Pacific Northwest (Oregon/Washington).

POPULATION SIZE

Aerial surveys of the inside waters of Washington and southern British Columbia were conducted during August of 1996 (Calambokidis et al. 1997). These aerial surveys included the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, and Strait of Georgia, which includes waters inhabited by harbor porpoise from British Columbia, as well as the Washington Inland Waters stock. A total of 2,117 km of survey effort was completed within U.S. waters, resulting in an uncorrected abundance of 1,025 (CV=0.151) harbor porpoise in the inside waters of Washington (Calambokidis et al. 1997, Laake et al. 1997a). When corrected for availability and perception bias, using a correction factor of 3.42 (1/g(0); g(0)=0.292, CV=0.366), the estimated abundance for the Washington Inland Waters stock of harbor porpoise is 3,509 (CV=0.396) animals (Laake et al. 1997a, 1997b).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 3,509 and its associated CV(N) of 0.396, N_{MIN} for the Washington Inland Waters stock of harbor porpoise is 2,545.

Current Population Trend

There are no reliable data on long-term population trends of harbor porpoise for most waters of Oregon, Washington, or British Columbia. For comparability to the 1996 survey, a re-analysis of the 1991 aerial survey data was conducted (Calambokidis et al. 1997). The abundance of harbor porpoise in the Washington Inland Waters stock in 1996 was not significantly different than in 1991 (Laake et al. 1997a).

A different situation exists in southern Puget Sound where harbor porpoises are now rarely observed, a sharp contrast to 1942 when they were considered common in those waters (Scheffer and Slipp 1948). Although quantitative data for this area are lacking, marine mammal survey effort (Everitt et al. 1980), stranding records since the early 1970s (Osmek et al. 1995), and the results of harbor porpoise surveys of 1991 (Calambokidis et al. 1992) and 1994 (Osmek et al. 1995) indicate that harbor porpoise abundance has declined in southern Puget Sound. In 1994 a total of 769 km of vessel survey effort and 492 km of aerial survey effort conducted during favorable sighting conditions produced no sightings of harbor porpoise in southern Puget Sound. Reasons for the apparent decline are unknown, but it may be related to fishery interactions, pollutants, vessel traffic, or other activities that may affect harbor porpoise occurrence and distribution in this area (Osmek et al. 1995). Research to identify trends in harbor porpoise abundance is also needed for the other areas within inland Washington waters.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is not currently available for harbor porpoise. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% (Wade and Angliss 1997) be employed for the Washington Inland Waters harbor porpoise stock.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (2,545) times one-half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.40 (for a stock of unknown status with a mortality rate CV $\geq$ 0.80, Wade and Angliss 1997), resulting in a PBR of 20 harbor porpoise per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

NMFS observers monitored the northern Washington marine set gillnet fishery during 1994-1998 and in 2000; there was no observer coverage in 1999 (Gearin et al. 1994, 2000; P. Gearin, unpubl. data). For the entire area fished (coastal + inland waters), observer coverage ranged from approximately 33 to 98% during observed years. Fishing effort is conducted within the range of both harbor porpoise stocks (Oregon/Washington Coast and Washington Inland Waters stocks) occurring in Washington State waters. For the purposes of this stock assessment report, the animals taken in the inland portion of the fishery are assumed to have belonged to the Washington Inland Waters stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon/Washington Coast stock. Some movement of harbor porpoise between Washington's coastal and inland waters is likely, but it is currently not possible to quantify the extent of such movements. Accordingly, Table 1 includes data only from that portion of the northern Washington marine set gillnet fishery occurring within the range of the Washington Inland Waters stock (those waters east of Cape Flattery), where observer coverage ranged from 6 to 80% between 1994 and 2000. From 1990 to 1993, fishing effort ranged from 215-469 net days per year (1 net day equals a 100-fathom length net set for 24 hours) in the inland portion of the fishery. Fishing effort decreased in subsequent years, ranging from 4-39 net days per year in 1994-2000, except in 1996 when effort equaled 99 net days. In 1994, the observer program was delayed because the biological opinion on the fishery, relating to takes of marbled murrelets under the ESA, was not completed by the time the fishery began. One vessel fished in the inland fishery in 1994 and 39% of the sets were observed. There was no observer program in 1999, however, the total fishing effort was only 4 net days (in inland waters) and no marine mammal takes were reported. Data from 1994-2000 are included in Table 1, although the mean estimated annual mortality is calculated using the most recent 5 years of available data. No mortalities were observed in the inland portion of the fishery between 1994 and 2000. The mean estimated mortality for this fishery is zero harbor porpoise per year from this stock.

In 1993, as a pilot for future observer programs, NMFS in conjunction with the Washington Department of Fish and Wildlife (WDFW) monitored all non-treaty components of the Washington Puget Sound Region salmon gillnet fishery (Pierce et al. 1994). Observer coverage was 1.3% overall, ranging from 0.9% to 7.3% for the various components of the fishery. No harbor porpoise mortalities were reported (Table 1). Pierce et al. (1994) cautioned against extrapolating these mortalities to the entire Puget Sound fishery due to the low observer coverage and potential biases inherent in the data. The area 7/7A sockeye landings represented the majority of the non-treaty salmon landings in 1993, approximately 67%. Results of this pilot study were used to design the 1994 observer programs discussed below.

In 1994, NMFS in conjunction with WDFW conducted an observer program during the Puget Sound non-treaty chum salmon gillnet fishery (areas 10/11 and 12/12B). A total of 230 sets were observed during 54 boat trips, representing approximately 11% observer coverage of the 500 fishing boat trips comprising the total effort in this fishery, as estimated from fish ticket landings (Erstad et al. 1996). No harbor porpoise were reported within 100 m of observed gillnets. The Puget Sound treaty chum salmon gillnet fishery in Hood Canal (areas 12, 12B, and 12C) and the Puget Sound treaty sockeye/chum gillnet fishery in the Strait of Juan de Fuca (areas 4B, 5, and 6C) were also monitored in 1994 (NWIFC 1995). No harbor porpoise mortalities were reported in the observer programs covering these treaty salmon gillnet fisheries, where observer coverage was estimated at 2.2% (based on % of total catch observed) and approximately 7.5% (based on % of observed trips to total landings), respectively.

Also in 1994, NMFS in conjunction with WDFW and the Tribes conducted an observer program to examine seabird and marine mammal interactions with the Puget Sound treaty and non-treaty sockeye salmon gillnet fishery (areas 7 and 7A). During this fishery, observers monitored 2,205 sets, representing approximately 7% of the estimated 33,086 sets occurring in the fishery (Pierce et al. 1996). There was one observed harbor porpoise mortality (one other was entangled and released alive with no indication that it was injured), resulting in a mortality rate of 0.00045 harbor porpoise per set, which extrapolates to 15 mortalities (CV=1.0) for the entire fishery.

In 1996, Washington Sea Grant Program conducted a test fishery in the non-treaty sockeye salmon gillnet fishery (area 7) to compare entanglement rates of seabirds and marine mammals and catch rates of salmon using three experimental gears and a control (monofilament mesh net). The experimental nets incorporated highly visible mesh in the upper quarter (50 mesh gear) or upper eighth (20 mesh gear) of the net or had low-frequency sound emitters attached to the corkline (Melvin et al. 1997). In 642 sets during 17 vessel trips, 2 harbor porpoise were killed in the 50 mesh gear.

Combining the estimates from the 1994 observer programs (15) with the northern Washington marine set gillnet fishery (0) results in an estimated mean mortality rate in observed fisheries of 15 harbor porpoise per year from this stock. It should be noted that the 1994 observer programs did not sample all segments of the entire Washington Puget Sound Region salmon set/drift gillnet fishery and, further, the extrapolation of total kill did not include effort for the unobserved segments of this fishery. Therefore, 15 is an underestimate of the harbor porpoise mortality due to the entire fishery. Although the percentage of the overall Washington Puget Sound Region salmon set/drift gillnet fishery effort that was observed in 1994 was not quantified, the observer programs covered those segments of the fishery which had the highest salmon catches, the majority of vessel participation, and the highest likelihood of interaction with harbor porpoise (J. Scordino, pers. comm.). Since the Washington Inland Waters stock of harbor porpoise occurs primarily in the Strait of Juan de Fuca and the San Juan Islands, it is unlikely that many harbor porpoise are taken in other areas of the Washington Puget Sound Region salmon gillnet fishery (i.e., Hood Canal and southern Puget Sound). Harbor porpoise takes in the Washington Puget Sound Region salmon drift gillnet fishery are unlikely to have increased since the fishery was last observed in 1994, due to reductions in the number of participating vessels and available fishing time (see details in Appendix 1). Fishing effort and catch have declined throughout all salmon fisheries in the region due to management efforts to recover ESA-listed salmonids.

Table 1. Summary of incidental mortality of harbor porpoise (Washington Inland Waters stock) due to commercial and tribal fisheries and calculation of the mean annual mortality rate; n/a indicates that data are not available. Mean annual takes are based on 1996-2000 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery: inland waters)	94 95 96 97 98 99 00	obs data	39% 24% 6% 80% 40% 0% 58%	0 0 0 0 0 n/a 0	0 0 0 0 0 n/a 0	0[1]
WA Puget Sound Region salmon set/drift gillnet (observer programs listed below covered segments of this fishery):	-	-	-	-	-	-
Puget Sound non-treaty salmon gillnet (all areas and species)	93	obs data	1.3%	0	0	see text
Puget Sound non-treaty chum salmon gillnet (areas 10/11 and 12/12B)	94	obs data	11%	0	0	0
Puget Sound treaty chum salmon gillnet (areas 12, 12B, and 12C)	94	obs data	2.2%	0	0	0
Puget Sound treaty chum and sockeye salmon gillnet (areas 4B, 5, and 6C)	94	obs data	7.5%	0	0	0

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Puget Sound treaty and non-treaty sockeye salmon gillnet (areas 7 and 7A)	94	obs data	7%	1	15	15 (1.0)
				Reported mortalities		
WA Puget Sound Region salmon set/drift gillnet	94-00	self reports	n/a	n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	see text
Unknown Puget Sound fishery	96-00	strand data		0, 0, 0, 0, 1		$\geq$ 0.2
Minimum total annual takes						$\geq$ 15.2 (1.0)

[1]1995-98 and 2000 mortality estimates are included in the average.

An additional source of information on the number of harbor porpoise killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1994 and 2000, there were no fishery self-reports of any harbor porpoise mortalities from the Washington Puget Sound Region salmon set/drift gillnet fishery (Table 1). Unlike the 1994 observer program data, the self-reported fisheries data cover the entire fishery. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates of harbor porpoise mortality. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-1995 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 in Angliss et al. 2001 for details).

Strandings of harbor porpoise wrapped in fishing gear or with injuries caused by interactions with gear are a final source of fishery-related mortality information. One fishery-related stranding of a harbor porpoise occurred in 2000. As the stranding could not be attributed to a particular fishery, it has been included in Table 1 as occurring in an unknown Puget Sound fishery. Fishery-related strandings during 1996-2000 resulted in an estimated annual mortality of 0.2 harbor porpoise from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

There are few data concerning the mortality of marine mammals incidental to commercial gillnet fisheries in Canadian waters, which have not been monitored but are known to have taken harbor porpoise in the past (Barlow et al. 1994, Stacey et al. 1997). As a result, the number of harbor porpoise from this stock currently taken in the waters of southern British Columbia is not known.

The minimum estimated fishery mortality and serious injury for this stock is 15.2 harbor porpoise per year, based on observer program data (15) and stranding data (0.2).

Other Mortality

According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region, no human-caused harbor porpoise mortalities or serious injuries were reported from non-fisheries sources in 1996-2000.

STATUS OF STOCK

Harbor porpoise are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the level of human-caused mortality and serious injury (15.2) is not known to exceed the PBR (20). Therefore, the Washington Inland Waters harbor porpoise stock is not classified as "strategic." The minimum total fishery mortality and serious injury for this stock (15.2) exceeds 10% of the calculated PBR (2.0) and, therefore, cannot be considered to be insignificant and approaching zero mortality and

serious injury rate. The status of this stock relative to its Optimum Sustainable Population (OSP) level and population trends is unknown, although harbor porpoise sightings in southern Puget Sound have declined since the 1940s.

Although this stock is not recognized as "strategic" at this time, there is cause for concern due to the following issues: 1) the estimated take level is close to exceeding the PBR, 2) the extent to which harbor porpoise from U.S. waters frequent the waters of British Columbia, and are therefore subject to fishery-related mortality, is unknown, and 3) the mortality rate is based on observer data from a subset of the Washington Puget Sound Region salmon set/drift gillnet fishery. However, fishing effort has decreased in recent years and preliminary analysis of data from vessel (1999, 2002) and aerial (2002) surveys does not indicate that any major decline in abundance or contraction in range has occurred since 1996.

REFERENCES

Angliss, R.P., D.P. DeMaster, and A.L. Lopez. 2001. Alaska marine mammal stock assessments, 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-124. 203 pp.

Barlow, J. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: I. Ship surveys. Fish. Bull. 86:417-432.

Barlow, J., and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. Rep. Int. Whal. Commn. Special Issue 16:123-140.

Barlow, J., C. W. Oliver, T. D. Jackson, and B. L. Taylor. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. Fish. Bull. 86:433-444.

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 USA and Canada and the east coast of the Russian Federation. Rep. Int. Whal. Commn. Special Issue 15:405-425.

Calambokidis, J., and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. *In:* Reynolds, J. E., III, and D. K. Odell (eds.), Proceedings of the second marine mammal stranding workshop: 3-5 December 1987, Miami, Florida. NMFS, NOAA Tech. Rep. NMFS 98:101-110.

Calambokidis, J., J. R. Evenson, J. C. Cubbage, P. J. Gearin, and S. D. Osmek. 1992. Harbor porpoise distribution and abundance off Oregon and Washington from aerial surveys in 1991. Final Report by Cascadia Research, Olympia, WA, to National Marine Mammal Laboratory, AFSC, NMFS, Seattle, WA. 44 pp.

Calambokidis, J., J. C. Cubbage, J. R. Evenson, S. D. Osmek, J. L. Laake, P. J. Gearin, B. J. Turnock, S. J. Jeffries, and R. F. Brown. 1993. Abundance estimates of harbor porpoise in Washington and Oregon waters. Final Report by Cascadia Research, Olympia, WA, to National Marine Mammal Laboratory, AFSC, NMFS, Seattle, WA. 55 pp.

Calambokidis, J., S. D. Osmek, and J. L. Laake. 1997. Aerial surveys for marine mammals in Washington and British Columbia inside waters. Final Report by Cascadia Research, Olympia, WA, to National Marine Mammal Laboratory, AFSC, NMFS, Seattle, WA. 96 pp.

Carretta, J. V., J. Barlow, K. A. Forney, M. M. Muto, and J. Baker. 2001. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-317. 280 pp.

Chivers, S. J., A. E. Dizon, P. J. Gearin, and K. M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises (*Phocoena phocoena*) indicated by molecular genetic analyses. J. Cetacean Res. Manage. 4(2):111-122.

Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-1983: status, abundance, and distribution. OCS Study MMS 84-0045. Pacific OCS Region Minerals Management Service, 1340 Sixth Street, Los Angeles, CA 90014. 284 pp.

Erstad, P., S. J. Jeffries, and D. J. Pierce. 1996. 1994 Report for the Puget Sound fishery observer program in management areas 10/11 & 12/12B: nontreaty chum gill net fishery. Final Report, Washington Dept. Fish and Wildlife, Olympia, WA. 14 pp.

Everitt, R. D., C. H. Fiscus, and R. L. DeLong. 1980. Northern Puget Sound marine mammals. U.S. Dep. Commer.,

EPA-6000/7-80-139. 134 pp.
Gaskin, D. E. 1984. The harbour porpoise *Phocoena phocoena* (L.): regional populations, status, and information on direct and indirect catches. Rep. Int. Whal. Commn. 34:569-586.
Gearin, P. J. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.
Gearin, P. J., S. R. Melin, R. L. DeLong, H. Kajimura, and M. A. Johnson. 1994. Harbor porpoise interactions with a chinook salmon set-net fishery in Washington State. Rep. Int. Whal. Commn. Special Issue 15:427-438.
Gearin, P. J., M. E. Gosho, J. L. Laake, L. Cooke, R. L. DeLong, and K. M. Hughes. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the state of Washington. J. Cetacean Res. Manage. 2(1):1-9.
Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnel, and K. C. Balcomb. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Ch. 1, *In:* Brueggeman, J. J. (ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. OCS Study MMS 91-0093.
Laake, J. L., R. L. DeLong, J. Calambokidis, and S. Osmek. 1997a. Abundance and distribution of marine mammals in Washington and British Columbia inside waters, 1996. Pp. 67-73, *In:* MMPA and ESA Implementation Program, 1996. AFSC Processed Report 97-10. 255 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
Laake, J. L., J. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997b. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manage. 61(1):63-75.
Melvin, E. F., L. L. Conquest, and J. K. Parrish. 1997. Seabird bycatch reduction: new tools for Puget Sound drift gillnet salmon fisheries. 1996 Sockeye and 1995 Chum Salmon Test Fisheries Final Report. Washington Sea Grant Program, Seattle, WA. 48pp.
Northwest Indian Fisheries Commission (NWIFC). 1995. Monitoring of marbled murrelet and marine mammal interactions with 1994 tribal gillnet fisheries in northern Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Final Report to NMFS, Contract No. 52ABNF400087, and USFWS. Unpubl. report. 41 pp. Available at NWIFC, 6730 Martin Way E, Olympia, WA 98516.
Osborne, R., J. Calambokidis, and E. M. Dorsey. 1988. A Guide to Marine Mammals of Greater Puget Sound. Island Publishers, Anacortes, WA. 191 pp.
Osmek, S., P. Rosel, A. Dizon, and R. DeLong. 1994. Harbor porpoise, *Phocoena phocoena*, population assessment in Oregon and Washington, 1993. 1993 Annual Report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 14 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
Osmek, S. D., M. B. Hanson, J. L. Laake, S. J. Jeffries, and R. L. DeLong. 1995. Harbor porpoise *Phocoena phocoena* population assessment studies for Oregon and Washington in 1994. 1994 Annual Report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 32 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
Osmek, S., J. Calambokidis, J. Laake, P. Gearin, R. DeLong, J. Scordino, S. Jeffries, and R. Brown. 1996. Assessment of the status of harbor porpoise, *Phocoena phocoena*, in Oregon and Washington waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-76. 46 pp.
Pierce, D. J., W. P. Ritchie, and R. Kreuziger. 1994. Preliminary findings of seabird interactions with the non-treaty salmon gill net fishery: Puget Sound and Hood Canal Washington. Unpubl. report. Washington Dept. Fish and Wildlife, Olympia, WA. 39 pp. Available at WDFW, 600 Capitol Way N, Olympia, WA, 98501.
Pierce, D. J., M. Alexandersdottir, S. J. Jeffries, P. Erstad, W. Beattie, and A. Chapman. 1996. Interactions of marbled murrelets and marine mammals with the 1994 Puget Sound sockeye gill net fishery. Final Report, Washington Dept. Fish and Wildlife, Olympia, WA. 21 pp.
Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Thesis, Univ. Calif. San Diego, La Jolla, CA. 191 pp.
Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, *Phocoena phocoena*, on inter-oceanic and regional scales. Can. J. Fish. Aquat. Sci. 52:1210-1219.
Scheffer, V. B., and J. W. Slipp. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. Am. Midl. Nat. 39(2):257-337.

Scordino, J. National Marine Fisheries Service, Northwest Region, 7600 Sand Point Way NE, Seattle, WA 98115.
Stacey, P. J., R. W. Baird, and D. A. Duffus. 1997. A preliminary evaluation of incidental mortality of small cetaceans in coastal fisheries in British Columbia, Canada. Mar. Mammal Sci. 13:321-326.
Taylor, B. L. Southwest Fisheries Science Center, NMFS, P.O. Box 271, La Jolla, CA 92038.
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.

Revised 12/15/2000

DALL'S PORPOISE (*Phocoenoides dalli*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Dall's porpoise are endemic to temperate waters of the North Pacific Ocean. Off the U.S. west coast, they are commonly seen in shelf, slope and offshore waters (Figure 1; Morejohn 1979). Sighting patterns from aerial and shipboard surveys conducted in California, Oregon and Washington at different times (Green et al. 1992, 1993; Mangels and Gerrodette 1994; Barlow 1995; Forney et al. 1995) suggest that north-south movement between these states occurs as oceanographic conditions change, both on seasonal and inter-annual time scales. The southern end of this population's range is not well-documented, but they are commonly seen off Southern California in winter, and during cold-water periods they probably range into Mexican waters off northern Baja California. The stock structure of eastern North Pacific Dall's porpoise is not known, but based on patterns of stock differentiation in the western North Pacific, where they have been more intensively studied, it is expected that separate stocks will emerge when data become available (Perrin and Brownell 1994). Although Dall's porpoise are not restricted to U.S. territorial waters, there are no cooperative management agreements with Mexico or Canada for fisheries which may take this species (e.g. gillnet fisheries). For the Marine Mammal Protection Act (MMPA) stock assessment reports, Dall's porpoises within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Alaskan waters.

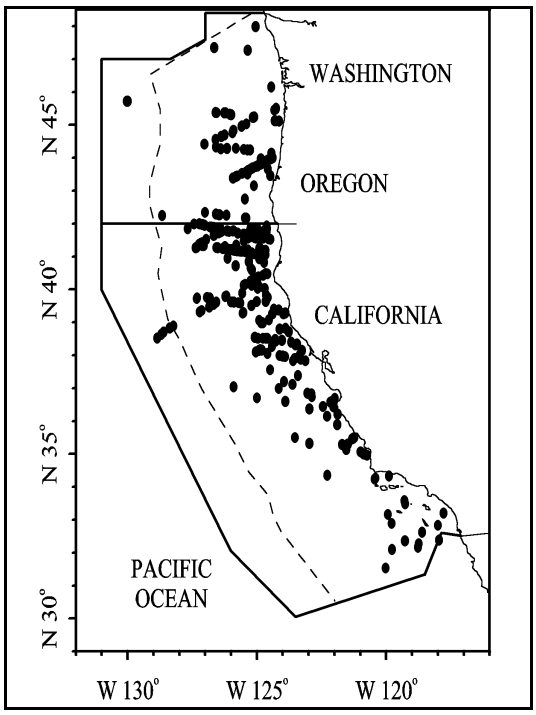

Figure 1. Dall's porpoise sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Shipboard surveys are expected to be more reliable for this species than aerial surveys because of the large, unknown fraction of diving animals missed from the air (Forney 1994). Three summer/fall shipboard surveys were conducted within 300 nmi of the coasts of California in 1991 and 1993 (Barlow and Gerrodette 1996) and California, Oregon and Washington in 1996 (Barlow 1997). The distribution of Dall's porpoise throughout this region is highly variable between years and appears to be affected by oceanographic conditions (Forney 1997; Forney and Barlow 1998). Because animals may spend time outside the U.S. Exclusive Economic Zone as oceanographic conditions change, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 116,016 (CV = 0.45) Dall's porpoise (Barlow 1997). Additional aerial surveys were conducted in the inland waters of Washington in 1991 and 1996, resulting in Dall's porpoise abundance estimates of 2,747 (CV=0.48) in 1991, and 900 (CV=0.40) in 1996 (Calambokidis et al. 1997), with a weighted average estimate of 1,509 (CV=0.46). Both estimates include approximate correction factors for animals missed due to perception and availability bias. Combining the average estimate for inland Washington waters with the 1991-96 outer coast estimate of Barlow (1997) yields a total abundance estimate of 117,545 (CV=0.45) Dall's porpoise for the California/Oregon/Washington stock.

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate for both the outer coast of California, Oregon and Washington and inland Washington waters is 81,866 Dall's porpoise.

Current Population Trend

No information is available regarding trends in abundance of Dall's porpoise in California, Oregon and Washington. Their distribution and abundance in this region varies considerably at both seasonal and interannual time scales as oceanographic conditions vary (Forney 1997; Forney and Barlow 1998).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for Dall's porpoise off the U.S. west coast.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (81,866) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.45 (for a species of unknown status and a mortality rate CV>0.60 and $\leq$ 0.80; Wade and Angliss 1997), resulting in a PBR of 737 Dall's porpoise per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for this stock of Dall's porpoise is given in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the relative rarity of Dall's porpoise entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 10 (CV = 0.95) Dall's porpoise taken annually.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take some Dall's porpoise from the same population during cold-water periods. 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 to be approximately 2700, 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.).

Low levels of mortality for Dall's porpoise have also been documented in the California/Oregon/Washington domestic groundfish trawl fisheries (Perez and Loughlin 1991; Perez, in prep). Between 1994 and 1998, with 54%-77% of the fishing effort observed, five Dall's porpoise were reported killed in the at-sea processing portion of the Pacific whiting trawl fishery, and five animals were reported in unmonitored hauls.. Based only on the systematically observed hauls, Dall's porpoise mortality was estimated to be five (CV=0.44) in 1997 and three (CV=0.33) in 1998 (Perez, in prep). Combining these estimates with the three reported mortalities for 1994 and 1996 that are not accounted for in the estimates, the minimum average annual mortality for 1994-98 is 2.0 (CV=0.23) Dall's porpoise per year.

STATUS OF STOCK

The status of Dall's porpoise in California, Oregon and Washington relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 (12 animals) is estimated to be less than the PBR (737), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury

for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

Table 1. Summary of available information on the incidental mortality and injury of Dall's porpoise (California/ Oregon/Washington Stock) in commercial fisheries that might take this species. All observed entanglements of Dall's porpoise resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994	17.9%	2	11 (0.64)	
		1995	15.6%	1	6 (0.92)	
		1996	12.4%	2	24 (0.68)	
		1997	23.0%	4	20 (0.95)	
		1998	20.0%	0	0	10 (0.95)[1]
WA/OR/CA domestic groundfish trawl fisheries (At-sea processing Pacific whiting fishery only).	observer data	1994	53.8%	0	0	
		1995	56.2%	0	0	
		1996	65.2%	0	0	1.6 (0.23)
		1997	65.7%	3	5 (0.44)	
		1998	77.3%	2	3 (0.33)	
	unmonitored hauls	1994		2		
		1996		1		0.6 (n/a)
		1997		2		
Minimum total annual takes						12 (CV=0.79)

[1] Only 1997-98 mortality estimates are included in the average because overall cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

REFERENCES

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. Admin. Rep. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25p.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-233. 15 pp.

Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998. 20 pp.

Calambokidis, J., S. Osmek, and J. L. Laake. 1997. Aerial surveys for marine mammals in Washington and British Columbia inside waters. Final Contract Report for Contract 52ABNF-6-00092, available from Cascadia Research Collective, Waterstreet Building 218 ½ West Forth Avenue, Olympia, Washington 98501.

Cameron, G., and K. A. Forney. 1999. 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.

Forney, K. A. 1994. Recent information on the status of odontocetes in Californian waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-202. 87 pp.

Forney, K. A. 1997. Patterns of variability and environmental models of relative abundance for California cetaceans. Ph.D. dissertation, Scripps Institution of Oceanography, University of California, San Diego.

Forney, K. A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-92. Mar. Mamm. Sci. 14:460-489.

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.
Green, G., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington. Ch. 1. *In*: Oregon and Washington Marine Mammal and Seabird Surveys. OCS Study 91-0093. Final Report prepared for Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior, Los Angeles, California.
Green, G., R. A. Grotefendt, M. A. Smultea, C. E. Bowlby, and R. A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington waters. Final Report prepared for NMFS, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, Washington, 98115, Contract #50ABNF200058.
Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.
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 mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.
Mangels, K. F. and Gerrodette, T. 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and Gulf of California aboard the NOAA ships *McARTHUR* and *DAVID STARR JORDAN* July 28 - November 6, 1993. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-211. 88 pp.
Morejohn, G. V. 1979. The natural history of Dall's porpoise in the North Pacific Ocean. *In:* Winn, H. E. and B. L. Olla (eds.), Behavior of Marine Mammals, p. 45-83. Plenum Press, New York - London.
Perez, M. A. and T. R. Loughlin. 1991. Incidental catch of marine mammals by foreign and joint venture trawl vessels in the U.S. EEZ of the North Pacific, 1973-88. U.S. Dep. Commer. NOAA Tech. Rep. 104. 57 p.
Perez, M. A. (in prep). Summary of marine mammal incidental catch data for domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-98. U.S. Dep. Commer. NOAA Tech. Memo.
Perrin, W. F. and R. L. Brownell, Jr. 1994. A brief review of stock identity in small marine cetaceans in relation to assessment of driftnet mortality in the North Pacific. Rep. Int. Whal. Commn. Special Issue 15:393-401.
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 R. P. 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.

Revised 12/15/2000

PACIFIC WHITE-SIDED DOLPHIN (*Lagenorhynchus obliquidens*): California/Oregon/Washington, Northern and Southern Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

Pacific white-sided dolphins are endemic to temperate waters of the North Pacific Ocean, and are common both on the high seas and along the continental margins. Off the U.S. west coast, Pacific white-sided dolphins have been seen primarily in shelf and slope waters (Figure 1). Sighting patterns from recent aerial and shipboard surveys conducted in California, Oregon and Washington at different times of the year (Green et al. 1992; 1993; Barlow 1995; Forney et al. 1995) suggest seasonal north-south movements, with animals found primarily off California during the colder water months and shifting northward into Oregon and Washington as water temperatures increase in late spring and summer (Green et al. 1992; Forney 1994).

Stock structure throughout the North Pacific is poorly understood, but based on morphological evidence, two forms are known to occur off the California coast (Walker et al. 1986; Chivers et al. 1993). Specimens belonging to the northern form were collected from north of about 33°N, (Southern California to Alaska), and southern specimens were obtained from about 36°N southward along the coasts of California and Baja California. Samples of both forms have been collected in the Southern California Bight, but it is unclear whether this indicates sympatry in this region or whether they may occur there at different times (seasonally or interannually). Recent genetic analyses have confirmed the distinctness of animals found off Baja California from animals occurring in U.S. waters north of Point Conception, California and in the high seas of the North Pacific (Lux et al. 1997). Based on these genetic data, a boundary or area of mixing between the two forms appears to be located off Southern California (Lux et al. 1997).

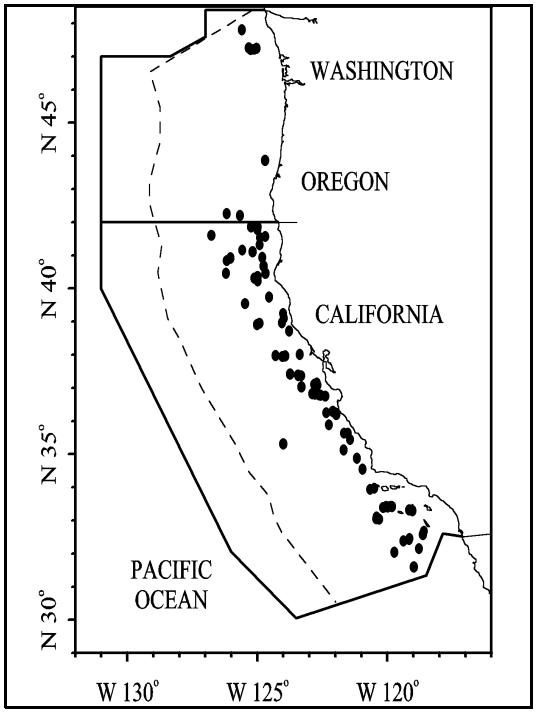

Figure 1. Pacific white-sided dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

Although there is clear evidence that two forms of Pacific white-sided dolphins occur along the U.S. west coast, there are no known differences in color pattern, and it is not currently possible to distinguish animals without genetic or morphometric analyses. Geographic stock boundaries appear dynamic and are poorly understood, and therefore cannot be used to differentiate the two forms. Until means of differentiating the two forms for abundance and mortality estimation are developed, these two stocks must be managed as a single unit; however, this is an undesirable management situation. Furthermore, Pacific white-sided dolphins are not restricted to U.S. territorial waters, but cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Additional means of differentiating the two types must be found, and cooperative management with Mexico is particularly important for this species, given the apparently dynamic nature of geographical stock boundaries. Until these goals are accomplished, the management stock includes animals of both forms. For the Marine Mammal Protection Act (MMPA) stock assessment reports, Pacific white-sided dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Alaskan waters.

POPULATION SIZE

The previous best estimates of abundance for Pacific white-sided dolphins (Barlow et al. 1997) were based

on winter/spring 1991-92 aerial surveys (Forney et al. 1995) off California, which were presumed to include Pacific white-sided dolphins that are found off Oregon and Washington during summer and fall. Three summer/fall shipboard surveys were conducted within 300 nmi of the coasts of California in 1991 and 1993 (Barlow and Gerrodette 1996) and California, Oregon and Washington in 1996 (Barlow 1997). The distribution of Pacific white-sided dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and interannual time scales (Forney and Barlow 1998). As oceanographic conditions vary, Pacific white-sided dolphins may spend time outside the U.S. Exclusive Economic Zone, and therefore a multi-year average abundance estimate including California, Oregon and Washington is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 25,825 (CV = 0.49) Pacific white-sided dolphins (Barlow 1997).

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 17,475 Pacific white-sided dolphins.

Current Population Trend

No long-term trends in the abundance of Pacific white-sided dolphins in California, Oregon and Washington are suggested based on historical and recent surveys (Dohl et al. 1980; 1983; Green et al. 1992; 1993; Barlow 1995; Forney et al. 1995;).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for Pacific white-sided dolphins off the U.S. west coast.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (17,475) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.45 (for a species of unknown status with a mortality rate CV $\geq$ 0.60 and $\leq$ 0.80; Wade and Angliss 1997), resulting in a PBR of 157 Pacific white-sided dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for this stock of Pacific white-sided dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the relative rarity of Pacific white-sided dolphin entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 6.0 (CV = 0.68) Pacific white-sided dolphins taken annually.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably take the southern form of this species. 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 2700, 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.).

Table 1. Summary of available information on the incidental mortality and injury of Pacific white-sided dolphins (California/ Oregon/Washington Stock) in commercial fisheries that might take this species. All observed entanglements of Pacific white-sided dolphins resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data					
		1994	17.9%	3	17 (0.67)	
		1995	15.6%	1	6 (0.92)	
		1996	12.4%	3	25 (0.96)	
		1997	23.0%	3	12 (0.68)	6.0 (0.68)[1]
		1998	20.0%	0	0	
WA/OR/CA domestic groundfish trawl fisheries (At-sea processing Pacific whiting fishery only).	observer data					
		1994	53.8%	0	0	
		1995	56.2%	0	0	
		1996	65.2%	0	0	0.2 (0.48)
		1997	65.7%	0	0	
		1998	77.3%	1	1 (0.48)	
	other records	1996		3	$\geq$ 3	0.6 (n/a)
Minimum total annual takes						6.8 (0.60)

[1] Only 1997-98 mortality estimates are included in the average because overall cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

Low levels of mortality for Pacific white-sided dolphins have also been documented in the California/Oregon/ Washington domestic groundfish trawl fisheries (Perez and Loughlin 1991; Perez, in prep;). Between 1994 and 1998, with 54%-77% of the fishing effort observed, one Pacific white-sided dolphin was reported killed in the at-sea processing portion of the Pacific whiting trawl fishery, and three additional animals were reported in unmonitored hauls. Based only on the systematically observed hauls, mortality was estimated to be one Pacific white-sided dolphin (CV=0.48, Perez, in prep) in 1998. Combining this estimate with the three additional reported mortalities for 1996 that are not accounted for in the estimate, the minimum average annual mortality for 1994-98 is 0.8 (CV=0.48) Pacific white-sided dolphins.

Other removals

Additional removals of Pacific white-sided dolphins from the wild have occurred in live-capture fisheries off California. Brownell et al. (1999) estimate a minimum total live capture of 128 Pacific white-sided dolphins between the late 1950s and 1993. The most recent capture was in November 1993, when three animals were taken for public display (Forney 1994). No MMPA permits are currently active for live-captures of Pacific white-sided dolphins.

STATUS OF STOCK

The status of Pacific white-sided dolphins in California, Oregon and Washington relative to OSP is not known, and there is no indication of a trend in abundance for this stock. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 (6.8 animals) is estimated to be less than the PBR (157), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

REFERENCES

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. Admin. Rep. LJ-97-11, Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25p.

Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20 pp.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. NOAA Tech. Memo. NMFS-SWFSC-233. 15 pp.

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. 223 pp.

Brownell, R. L., Jr., W. A. Walker and K. A. Forney. 1999. Pacific white-sided dolphin, *Lagenorhynchus obliquidens* Gill, 1865. Pages 57-84 *In:* Ridgway, S. H. and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 6. Academic Press, San Diego.

Cameron, G., and K. A. Forney. 1999. 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.

Chivers, S. J., K. M. Peltier, W. T. Norman, P. A. Akin, and J. Heyning. 1993. Population structure of cetaceans in California coastal waters. Paper SOCCS9 presented at the Status of California Cetacean Stocks Workshop, held in La Jolla, California, March 31-April 2, 1993. 49p.

Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-1983: Status, abundance and distribution. OCS Study MMS 84-0045. Minerals Management Service Contract # 14-12-0001-29090. 284p.

Dohl, T. P., K. S. Norris, R. C. Guess, J. D. Bryant, and M. W. Honig. 1980. Summary of marine mammal and seabird surveys of the Southern California Bight area, 1975-1978. Part II. Cetacea of the Southern California Bight. Final Report to the Bureau of Land Management, NTIS Rep. No. PB81248189. 414p.

Forney, K. A. 1994. Recent information on the status of odontocetes in Californian waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-202. 87 pp.

Forney, K. A. 1997. Patterns of variability and environmental models of relative abundance for California cetaceans. Ph.D. dissertation, Scripps Institution of Oceanography, University of California, San Diego.

Forney, K. A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-92. Mar. Mamm. Sci. 14:460-489.

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.

Green, G., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington. Ch. 1. In: Oregon and Washington Marine Mammal and Seabird Surveys. OCS Study 91-0093. Final Report prepared for Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior, Los Angeles, California.

Green, G., R. A. Grotefendt, M. A. Smultea, C. E. Bowlby, and R. A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington waters. Final Report prepared for NMFS, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, Washington, 98115, Contract #50ABNF200058.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

Lux, C. A., A. S. Costa, and A. E. Dizon. 1997. Mitochondrial DNA population structure of the Pacific white-sided dolphin. Rep. Int. Whaling. Commn. 47:645-652.

Perez, M. A. and T. R. Loughlin. 1991. Incidental catch of marine mammals by foreign and joint venture trawl vessels in the U.S. EEZ of the North Pacific, 1973-88. NOAA Tech. Rep. NMFS 104. 57 pp.

Perez, M. A. (in prep). Summary of marine mammal incidental catch data for domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-98. NOAA Tech. Memo.

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 R. P. 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.

Walker, W. A., S. Leatherwood, K. R. Goodrich, W. F. Perrin and R. K. Stroud. 1986. Geographical variation and biology of the Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, in the north-eastern Pacific. *In:* Bryden, M. M. and R. Harrison (eds.), Research on Dolphins, p. 441-465. Clarendon Press, Oxford.

Revised 12/15/2000

RISSO'S DOLPHIN (*Grampus griseus*):California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Risso's dolphins are distributed world-wide in tropical and warm-temperate waters. Off the U.S. West coast, Risso's dolphins are commonly seen on the shelf in the Southern California Bight and in slope and offshore waters of California, Oregon and Washington. Based on sighting patterns from recent aerial and shipboard surveys conducted in these three states during different seasons (Figure 1), animals found off California during the colder water months are thought to shift northward into Oregon and Washington as water temperatures increase in late spring and summer (Green et al. 1992). The southern end of this population's range is not well-documented, but on a recent joint U.S./Mexican ship survey, Risso's dolphins were sighted off northern Baja California, and a conspicuous 500 nmi gap was present between these animals and Risso's dolphins sighted south of Baja California and in the Gulf of California (Mangels and Gerrodette 1994). Thus this population appears distinct from animals found in the eastern tropical Pacific and the Gulf of California. Although Risso's dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). For the Marine Mammal Protection Act (MMPA) stock assessment reports, Risso's dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Hawaiian waters.

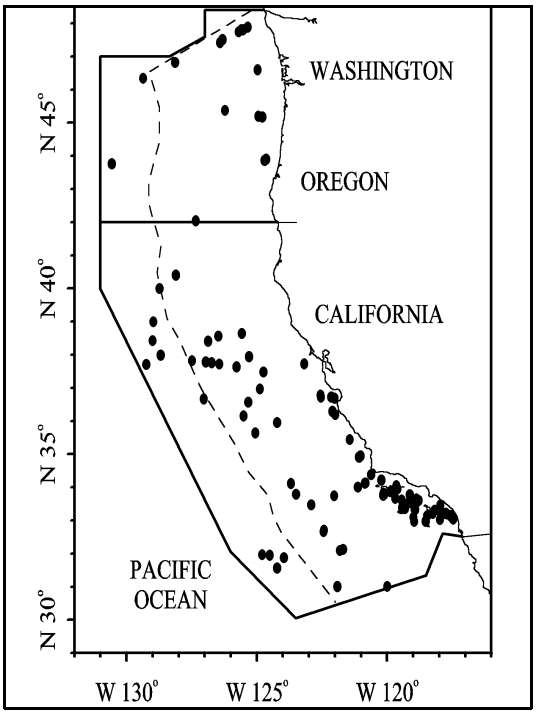

Figure 1. Risso's dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

The previous best estimates of abundance for Risso's dolphins (Barlow et al. 1997) were based on winter/spring 1991-92 aerial surveys (Forney et al. 1995) off California, which were presumed to include Risso's dolphins that are found off Oregon and Washington during summer and fall. Three summer/fall shipboard surveys were conducted within 300 nmi of the coasts of California in 1991 and 1993 (Barlow and Gerrodette 1996) and California, Oregon and Washington in 1996 (Barlow 1997). The distribution of Risso's dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and interannual time scales (Forney and Barlow 1998). As oceanographic conditions vary, Risso's dolphins may spend time outside the U.S. Exclusive Economic Zone, and therefore a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 16,483 (CV = 0.28) Risso's dolphins (Barlow 1997).

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 13,079 Risso's dolphins.

Current Population Trend

Although sighting records of Risso's dolphins appear to have increased during the last two decades in some areas off the U.S. West coast (Green et al. 1992; 1993; Shane 1994), sampling effort has also increased, and there are no statistical estimates of historical abundance on which to base a quantitative comparison. Thus, it is possible that Risso's dolphin abundance off the U.S. West coast has increased, but no definitive statement regarding trends in

abundance of Risso's dolphins off California, Oregon and Washington can be made.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for Risso's dolphins in California, Oregon and Washington.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (13,079) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.40 (for a species of unknown status with a mortality rate CV ≥ 0.80; Wade and Angliss 1997), resulting in a PBR of 105 Risso's dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for this stock of Risso's dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the relative rarity of Risso's dolphin entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 5.5 (CV = 0.96) Risso's dolphins taken annually.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably 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 2700, 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.).

Table 1. Summary of available information on the incidental mortality and injury of Risso's dolphin (California/ Oregon/Washington Stock) in commercial fisheries that might take this species. All observed entanglements of Risso's dolphins resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9% 15.6% 12.4% 23.0% 20.0%	1 6 0 3 0	6 (0.91) 39 (0.57) 0 11 (0.96) 0	5.5 (0.96) [1]
Minimum total annual takes						5.5 (0.96)

[1] Only 1997-98 mortality estimates are included in the average because overall cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

Additional mortality of unknown extent has been documented for Risso's dolphins in the squid purse seine fishery off Southern California (Heyning et al. 1994). This mortality probably represented animals killed intentionally

to protect catch or gear, rather than incidental mortality, and such intentional takes are now illegal under the 1994 Amendment to the MMPA. This fishery has expanded markedly since 1992 (California Department of Fish and Game, unpubl. data). No recent Risso's dolphin mortality has been reported for this fishery, but it is currently not monitored.

STATUS OF STOCK

The status of Risso's dolphins off California, Oregon and Washington relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 (5.5 animals) is estimated to be less than the PBR (105), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

REFERENCES

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. Admin. Rep. LJ-97-11, Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25p.

Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20 pp.

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 T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. NOAA Tech. Memo. NMFS-SWFSC-233. 15 pp.

Cameron, G., and K. A. Forney. 1999. 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.

Forney, K. A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-92. Mar. Mamm. Sci. 14:460-489.

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.

Green, G., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington. Ch. 1. In: Oregon and Washington Marine Mammal and Seabird Surveys. OCS Study 91-0093. Final Report prepared for Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior, Los Angeles, California.

Green, G., R. A. Grotefendt, M. A. Smultea, C. E. Bowlby, and R. A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington waters. Final Report prepared for NMFS, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, Washington, 98115, Contract #50ABNF200058.

Heyning, J. E., T. D. Lewis and C. D. Woodhouse. 1994. A note on odontocete mortality from fishing gear entanglements off Southern California. Rep. Int. Whal. Commn. Special Issue 15:439-442.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

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 mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

Mangels, K. F. and Gerrodette, T. 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and Gulf of California aboard the NOAA ships *McARTHUR* and *DAVID STARR JORDAN* July

28 - November 6, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-211. 88 pp.
Shane, S. 1994. Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983-91. Bull. Southern California Acad. Sci. 93:13-29.
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 R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commerce, NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

Revised 12/31/2001

BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California Coastal Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bottlenose dolphins are distributed worldwide in tropical and warm-temperate waters. In many regions, including California, separate coastal and offshore populations are known (Walker 1981; Ross and Cockcroft 1990; Van Waerebeek et al. 1990). California coastal bottlenose dolphins are found within about one kilometer of shore (Figure 1; Hansen, 1990; Carretta et al. 1998; Defran and Weller 1999) primarily from Point Conception south into Mexican waters, at least as far south as Ensenada. In southern California, animals are found within 500 m of the shoreline 99% of the time and within 250 m 90% of the time (Hanson and Defran 1993). Oceanographic events appear to influence the distribution of animals along the coasts of California and Baja California, Mexico, as indicated by a change in residency patterns along Southern California and a northward range extension into central California after the 1982-83 El Niño (Hansen and Defran 1990; Wells et al. 1990). Since the 1982-83 El Niño, which increased water temperatures off California, they have been consistently sighted in central California as far north as San Francisco. Photo-identification studies have documented north-south movements of coastal bottlenose dolphins (Hansen 1990; Defran et al. 1999), and monthly counts based on surveys between the U.S./Mexican border and Point Conception are variable (Carretta et al. 1998), indicating that animals are probably moving into and out of this area. Although coastal bottlenose dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Therefore, the management stock includes only animals found within U.S. waters. For the Marine Mammal Protection Act (MMPA) stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into three stocks: 1) California coastal stock (this report), 2) California, Oregon and Washington offshore stock, and 3) Hawaiian stock.

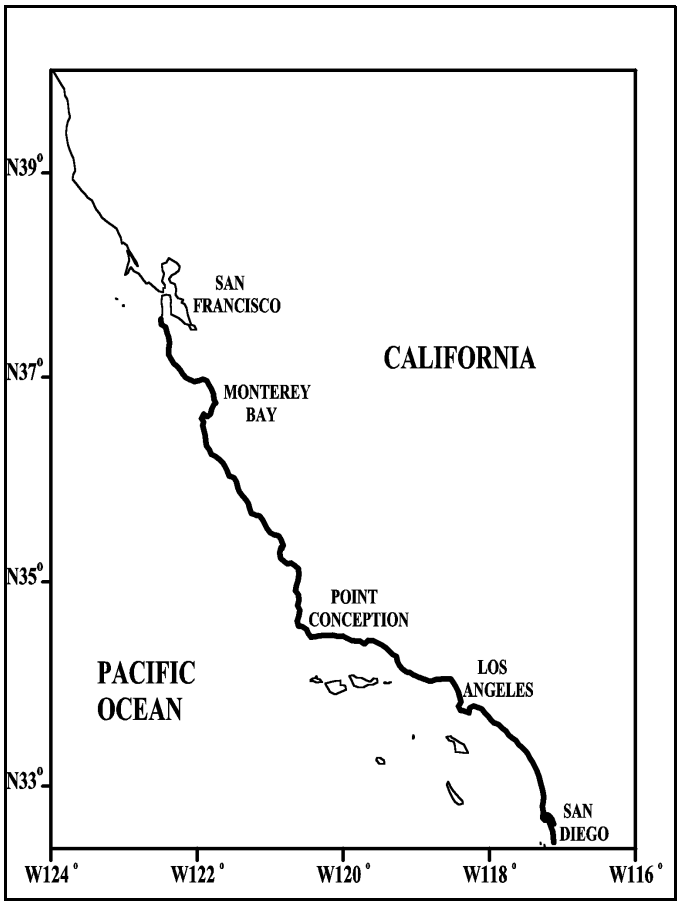

Figure 1. Approximate range (in bold) of California coastal bottlenose dolphins based on aerial surveys along the coast of California from 1990-2000. This population of bottlenose dolphins is found within about 1 km of shore.

POPULATION SIZE

Photo-identification studies along the coasts of southern California and northern Mexico identified 404 unique individuals in this population between 1981 and 1989 based on dorsal fin characteristics, with an estimated 35% of animals lacking identifiable characters at any particular time (Defran and Weller 1999). This cannot be considered a minimum population estimate, however, because an unknown number of animals died during this period and rates of acquisition of dorsal fin characters are not known. Mark-recapture estimates based on photo-identification studies in 1985-89 range from 234 (95% CI 205-263) to 285 (95% CI 265-306) animals for the entire California-Mexico population (Defran and Weller 1999). A recent re-analysis of mark-recapture estimates from the 1980s resulted in revised abundance estimates of 289 (95% CI 230-298) for the period 1984-86 and 354 (95% CI 330-390) for 1987-89

(Dudzik 1999). The most recent photographic mark-recapture abundance estimate is 356 (95% CI 306 - 437) for the period 1996-98 (Dudzik 1999). Because coastal bottlenose dolphins spend an unknown amount of time in Mexican waters, where they are subject to mortality in Mexican fisheries, an average abundance estimate for California only is the most appropriate for U.S. management of this stock. Tandem aerial surveys were conducted in 1990-94 and 1999-2000 to estimate the abundance of coastal bottlenose dolphins throughout the southern and central California portion of their range and to correct for the fraction of animals missed by a single observer team. (Carretta et al. 1998, NMFS, SWFSC, unpublished data). Aerial survey correction factors have been improved using recent information on California coastal bottlenose dolphin swim speeds (Ward 1999). Using the same methods as Carretta et al. (1998), the weighted average abundance estimate for the 1999-2000 surveys is 206 (CV=0.12) coastal bottlenose dolphins (NMFS, SWFSC, unpublished data). This presently is the best estimate of the average number of coastal bottlenose dolphins in U.S. waters.

Minimum Population Estimate

The log-normal 20th percentile of the above average abundance estimate for U.S. waters based on the 1999-2000 surveys is 186 coastal bottlenose dolphins.

Current Population Trend

Based on a comparison of mark-recapture abundance estimates for the periods 1987-89 ($\hat{N}$= 354) and 1996-98 ($\hat{N}$= 356), Dudzik (1999) stated that the population size had remained stable over an 11-year period.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for California coastal bottlenose dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (186) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 1.9 coastal bottlenose dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Due to its exclusive use of coastal habitats, this bottlenose dolphin population is susceptible to fishery-related mortality in coastal set net fisheries. A summary of information on fishery mortality and injury for this stock of bottlenose dolphin is shown in Table 1. More detailed information on the set gillnet fishery is provided in Appendix 1. From 1991-94, no bottlenose dolphins were observed taken in this fishery with 10-15% observer coverage (Julian and Beeson 1998). The observer program was discontinued at the end of 1994, when coastal set gillnet fishing was banned within 3 nmi of the southern California coast. In central California, gillnets have been restricted to waters deeper than 30 fathoms (56m) since 1991 in all areas except between Point Sal and Point Arguello. In 2001, gillnets were banned inshore of 60 fathoms from Point Reyes to Point Arguello by the California Department of Fish and Game. Because of these closures, the potential for mortality of coastal bottlenose dolphins in the California set gillnet fishery has been greatly reduced. Fisher self-report data and stranding records for 1994-98 do not include any records of fishery interactions for this stock. Coastal gillnet fisheries exist in Mexico and probably take animals from this population, but no details are available.

Table 1. Summary of available information on the incidental mortality and serious injury of bottlenose dolphins (California Coastal Stock) in commercial fisheries that might take this species.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes
CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery	observer data	1995-98[1] 1999[2]	0.0 % 4.0 %	0	0	0
Minimum total annual takes						0

[1]The CA set gillnets were not observed from 1995-98; mortality was extrapolated from effort estimates and previous entanglement rates.
[2]Set gillnet observer coverage in 1999 was limited to Monterey Bay fishing effort only.

Other removals

Seven coastal bottlenose dolphins were collected during the late 1950s in the vicinity of San Diego (Norris and Prescott 1961). Twenty-seven additional bottlenose dolphins were captured off California between 1966 and 1982 (Walker 1975; Reeves and Leatherwood 1984), but based on the locations of capture activities, these animals probably were offshore bottlenose dolphins (Walker 1975). No additional captures of coastal bottlenose dolphins have been documented since 1982, and no live-capture permits are currently active for this species.

STATUS OF STOCK

The status of coastal bottlenose dolphins in California relative to OSP is not known, and there is no evidence of a trend in abundance. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Because no recent fishery takes have been documented, coastal bottlenose dolphins are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

Habitat Issues

Pollutant levels, especially DDT residues, found in Southern California coastal bottlenose dolphins have been found to be among the highest of any cetacean examined (O'Shea et al. 1980; Schafer et al. 1984). Although the effects of pollutants on cetaceans are not well understood, they may affect reproduction or make the animals more prone to other mortality factors (Britt and Howard 1983; O'Shea et al. 1999). This population of bottlenose dolphins may also be vulnerable to the effects of morbillivirus outbreaks, which were implicated in the 1987-88 mass mortality of bottlenose dolphins on the U.S. Atlantic coast (Lipscomb et al. 1994).

REFERENCES

Britt, J. O. and E. B. Howard. 1983. Tissue residues of selected environmental contaminants in marine mammals. *In:* Howard, E. B. (ed.), Pathobiology of Marine Mammal Diseases. CRC Press, Boca Raton, Florida.

Carretta, J. V., K. A. Forney and J. L. Laake. 1998. The abundance of southern California coastal bottlenose dolphins estimated from tandem aerial surveys. Mar. Mamm. Sci. 14:655-675.

Defran, R. H. and D. W. Weller. 1999. Occurrence, distribution, site fidelity and school size of bottlenose dolphins (*Tursiops truncatus*) off San Diego, California. Mar. Mamm. Sci. 15:366-380.

Defran, R. H., D. W. Weller, D. L. Kelly, and M. A. Espinosa. 1999. Range characteristics of Pacific coast bottlenose dolphins (*Tursiops truncatus*) in the Southern California Bight. Mar. Mamm. Sci. 15:381-393.

Dudzik, K.J. 1999. Population dynamics of the Pacific coast bottlenose dolphin (*Tursiops truncatus*). M.S. Thesis, San Diego State University, San Diego, California 92182. 63pp.

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.

Hansen, L. J. 1990. California coastal bottlenose dolphins. *In*: S. Leatherwood and R.R. Reeves (eds.), The Bottlenose Dolphin, p. 403-420. Academic Press, Inc., San Diego.

Hansen, L. J. and R. H. Defran. 1990. A comparison of photo-identification studies of California coastal bottlenose dolphins. Rep. Int. Whal. Commn. Special Issue 12:101-104.

Hanson, M.T. and R.H. Defran. 1993. The behavior and feeding ecology of the Pacific coast bottlenose dolphin,

Tursiops truncatus. Aquatic Mammals 19:127-142.
Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.
Lipscomb, T. P., F. Y. Schulman, D. Moffett, and S. Kennedy. 1994. Morbilliviral disease in Atlantic bottlenose dolphins (*Tursiops truncatus*) from the 1987-88 epizootic. Journal of Wildlife Diseases 30:567-571.
O'Shea, T. J., R. L. Brownell, Jr., D. R. Clark, W. A. Walker, M. L. Gray, and T. G. Lamont. 1980. Organochlorine pollutants in small cetaceans from the Pacific and South Atlantic Oceans, November 1968-June 1976. Pesticides Monitoring Journal 14:35-46.
O'Shea, T. J., R. R. Reeves, and A. Kirk Long (eds.). 1999. Marine Mammals and Persistent Ocean Contaminants: Proceedings of the Marine Mammal Commission Workshop, Keystone, Colorado, 12-15 October 1998. Marine Mammal Commission, Bethesda, MD. 150pp.
NMFS, Southwest Fisheries Science Center. P.O. Box 271, La Jolla, CA 92038-0271
Norris, K. S. and J. H. Prescott. 1961. Observation on Pacific cetaceans of Californian and Mexican waters. University of California Publications in Zoology 63:291-402. University of California Press, Berkeley and Los Angeles.
Reeves, R. R. and S. Leatherwood. 1984. Live-capture fisheries for cetaceans in USA and Canadian waters, 1973-1982. Rep. Int. Whal. Commn. 34:497-507.
Ross, G. J. B. and V. G. Cockcroft. 1990. Comments on Australian bottlenose dolphins and the taxonomic status of *Tursiops aduncus* (Ehrenberg, 1832). *In*: The Bottlenose Dolphin (eds. S. Leatherwood and R. R. Reeves). pp. 101-128. Academic Press, 653pp.
Schafer, H. A., R. W. Gossett, C. F. Ward, and A. M. Westcott. 1984. Chlorinated hydrocarbons in marine mammals. Biennial Report, 1983-84, Southern California Coastal Water Research Project, Long Beach, California.
Van Waerebeek, K., J. C. Reyes, A. J. Read, and J. S. McKinnon. 1990. Preliminary observations of bottlenose dolphins from the Pacific coast of South America. *In*: The Bottlenose Dolphin (eds. S. Leatherwood and R. R. Reeves). pp. 143-154 Academic Press, 653 pp.
Walker, W. A. 1975. Review of the live-capture fishery for smaller cetaceans taken in Southern California waters for public display, 1966-77. J. Fish. Res. Board. Can. 32:1197-1211.
Walker, W. A. 1981. Geographical variation in morphology and biology of bottlenose dolphins (*Tursiops*) in the eastern North Pacific. Admin. Rep. LJ-81-03C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038, USA. 52p.
Ward, B.G. 1999. Movement patterns and feeding ecology of the Pacific coast bottlenose dolphin (*Tursiops truncatus*). M.S. Thesis, San Diego State University, San Diego, California, 92182. 98pp.
Wells, R. S., L. J. Hansen, A. B. Baldridge, T. P. Dohl, D. L. Kelly and R. H Defran. *In*: S. Leatherwood and R. R. Reeves (eds.), The Bottlenose Dolphin, p. 421-431. Academic Press, Inc., San Diego.
Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commerce, NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

Revised 12/15/2000

BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California/Oregon/Washington Offshore Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bottlenose dolphins are distributed world-wide in tropical and warm-temperate waters. In many regions, including California, separate coastal and offshore populations are known (Walker 1981; Ross and Cockcroft 1990; Van Waerebeek et al. 1990). On surveys conducted off California, offshore bottlenose dolphins have been found at distances greater than a few kilometers from the mainland and throughout the Southern California Bight. They have also been documented in offshore waters as far north as about 41°N (Figure 1), and they may range into Oregon and Washington waters during warm-water periods. Sighting records off California and Baja California (Lee 1993; Mangels and Gerrodette 1994) suggest that offshore bottlenose dolphins have a continuous distribution in these two regions. Based on aerial surveys conducted during winter/spring 1991-92 (Forney et al. 1995) and shipboard surveys conducted in summer/fall 1991 (Barlow 1995), no seasonality in distribution is apparent (Forney and Barlow 1998). Offshore bottlenose dolphins are not restricted to U.S. waters, but cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Therefore, the management stock includes only animals found within U.S. waters. For the Marine Mammal Protection Act (MMPA) stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into three stocks: 1) California coastal stock, 2) California, Oregon and Washington offshore stock (this report), and 3) Hawaiian stock.

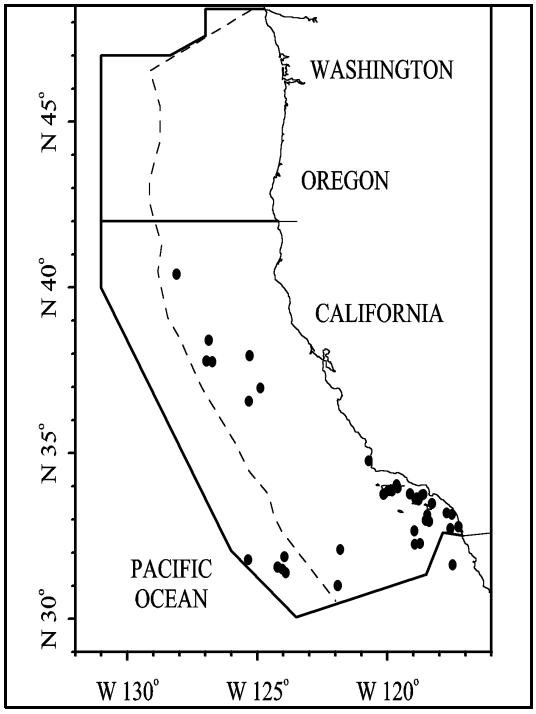

Figure 1. Offshore bottlenose dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). All sightings were made at distances greater than a few kilometers from the mainland California coast. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

The previous best estimates of abundance for offshore bottlenose dolphins (Barlow et al. 1997) were based on a weighted average for winter/spring 1991-92 aerial surveys (Forney et al. 1995), and summer/fall ship surveys in 1991 and 1993 (Barlow and Gerrodette 1996) along the coast of California. An additional summer/fall shipboard surveys was conducted within 300 nmi of the coasts of California, Oregon and Washington in 1996 (Barlow 1997). Because the distribution of bottlenose dolphins appears to vary interannually and they may spend time outside the U.S. Exclusive Economic Zone, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The most comprehensive multi-year average abundance is the weighted average abundance estimate for California, Oregon and Washington waters based on the 1991-96 ship surveys, 956 (CV = 0.14) offshore bottlenose dolphins (Barlow 1997).

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 850 offshore bottlenose dolphins.

Current Population Trend

No information on trends in abundance of offshore bottlenose dolphins is available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this population of offshore bottlenose dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (850) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 8.5 offshore bottlenose dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of known fishery mortality and injury for this stock of bottlenose dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the rarity of bottlenose dolphin entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of zero offshore bottlenose dolphins taken annually.

Table 1. Summary of available information on the incidental mortality and injury of bottlenose dolphins (California/ Oregon/Washington Offshore Stock) in commercial fisheries that might take this species. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994	17.9%	0	0	0 [1]
		1995	15.6%	0	0	
		1996	12.4%	0	0	
		1997	23.0%	0	0	
		1998	20.0%	0	0	
Minimum total annual takes						0

[1] Only 1997-98 mortality estimates are included in the average because overall cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico 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 2700, 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.).

Offshore bottlenose dolphins are often associated with Risso's dolphins and pilot whales, for which mortality has been documented in the squid purse seine fishery off Southern California (Heyning et al. 1994). Based on this association, offshore bottlenose dolphins may also have experienced some mortality in this fishery. However these would probably represent animals killed intentionally to protect catch or gear, rather than incidental kills, and such intentional takes are now illegal under the 1994 Amendment to the MMPA.

Other removals

Twenty-seven bottlenose dolphins were captured off California between 1966 and 1982 (Walker 1975; Reeves and Leatherwood 1984). Based on the locations of capture activities, these animals probably were offshore bottlenose dolphins (Walker 1975). No additional captures of bottlenose dolphins off California have been documented since 1982, and no MMPA live-capture permits are currently active for this species.

STATUS OF STOCK

The status of offshore bottlenose dolphins in California relative to OSP is not known, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Because no recent fishery takes have been documented, offshore bottlenose dolphins are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

REFERENCES

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. Admin. Rep. LJ-97-11, Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25p.

Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20 pp.

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 T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-233. 15 pp.

Cameron, G., and K. A. Forney. 1999. 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.

Forney, K. A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-92. Mar. Mamm. Sci. 14:460-489.

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.

Heyning, J. E., T. D. Lewis and C. D. Woodhouse. 1994. A note on odontocete mortality from fishing gear entanglements off Southern California. Rep. Int. Whal. Commn. Special Issue 15:439-442.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

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 mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. U.S. Dep. Commer.,

NOAA Tech. Memo. NMFS-SWFSC-181. 184 pp.

Mangels, K. F. and Gerrodette, T. 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and Gulf of California aboard the NOAA ships *McARTHUR* and *DAVID STARR JORDAN* July 28 - November 6, 1993. NOAA Tech. Memo. NMFS, NMFS-SWFSC-211. 88 pp.

Reeves, R. R. and S. Leatherwood. 1984. Live-capture fisheries for cetaceans in USA and Canadian waters, 1973-1982. Rep. Int. Whal. Commn 34:497-507.

Ross, G. J. B. and V. G. Cockcroft. 1990. Comments on Australian bottlenose dolphins and the taxonomic status of *Tursiops aduncus* (Ehrenberg, 1832). *In*: The Bottlenose Dolphin (eds. S. Leatherwood and R. R. Reeves). pp. 101-128. Academic Press, 653pp.

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.

Van Waerebeek, K., J. C. Reyes, A. J. Read, and J. S. McKinnon. 1990. Preliminary observations of bottlenose dolphins from the Pacific coast of South America. *In*: The Bottlenose Dolphin (eds. S. Leatherwood and R. R. Reeves). pp. 143-154 Academic Press, 653 pp.

Walker, W. A. 1975. Review of the live-capture fishery for smaller cetaceans taken in Southern California waters for public display, 1966-77. J. Fish. Res. Board. Can. 32:1197-1211.

Walker, W. A. 1981. Geographical variation in morphology and biology of bottlenose dolphins (*Tursiops*) in the eastern North Pacific. Admin. Rep. LJ-81-03C. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA 92038. 52p.

Wade, P. R. and R. P. 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.

Revised 12/15/2000

STRIPED DOLPHIN (*Stenella coeruleoalba*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Striped dolphins are distributed world-wide in tropical and warm-temperate pelagic waters. On recent shipboard surveys extending about 300 nmi offshore of California, they were sighted within about 100-300 nmi from the coast (Figure 1). No sightings have been reported for Oregon and Washington waters, but striped dolphins have stranded in both states (Oregon Department of Fish and Wildlife, unpublished data; Washington Department of Fish and Wildlife, unpublished data). Striped dolphins are also commonly found in the central North Pacific, but sampling between this region and California has been insufficient to determine whether the distribution is continuous. Based on sighting records off California and Mexico, striped dolphins appear to have a continuous distribution in offshore waters of these two regions (Perrin et al. 1985; Mangels and Gerrodette 1994). No information on possible seasonality in distribution is available, because the California surveys which extended 300 nmi offshore were conducted only during the summer/fall period. Although striped dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Therefore, the management stock includes only animals found within U.S. waters. For the Marine Mammal Protection Act (MMPA) stock assessment reports, striped dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) waters around Hawaii.

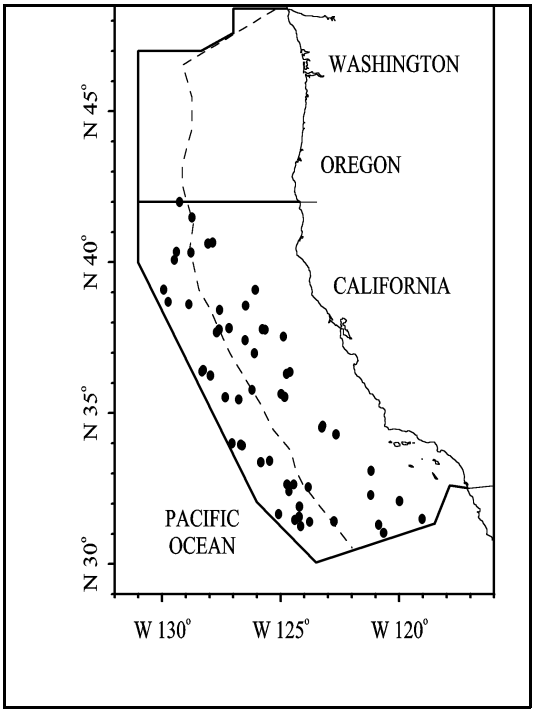

Figure 1. Striped dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Three summer/fall shipboard surveys were conducted within 300 nmi of the coasts of California in 1991 and 1993 (Barlow and Gerrodette 1996) and California, Oregon and Washington in 1996 (Barlow 1997). The abundance of striped dolphins in this region appears to be variable between years and may be affected by oceanographic conditions, as with other odontocete species (Forney 1997, Forney and Barlow 1998). Because animals may spend time outside the U.S. Exclusive Economic Zone as oceanographic conditions change, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the above three ship surveys is 20,235 (CV = 0.14) striped dolphins (Barlow 1997).

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 17,995 striped dolphins.

Current Population Trend

Prior to the 1991 shipboard survey (Barlow 1995), striped dolphins were not thought to be common off California (Leatherwood et al. 1982), and two surveys extending approximately 200 nmi offshore of California and Baja California in 1979 and 1980 resulted in only one sighting of three striped dolphins (Smith et al. 1986). Thus it is

possible that striped dolphin abundance off California has increased over the last decade (consistent with the observed warming trend for these waters; Roemmich 1992); however, no definitive statement can be made, because statistical estimates of abundance were not obtained for the earlier surveys.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for striped dolphins off California.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (17,995) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 180 striped dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for this stock of striped dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the rarity of striped dolphin entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of zero striped dolphins taken annually.

Table 1. Summary of available information on the incidental mortality and injury of striped dolphins (California/ Oregon/Washington Stock) in commercial fisheries that might take this species. The single observed entanglement of a striped dolphin resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994	17.9%	1	6 (0.90)	0 [1]
		1995	15.6%	0	0	
		1996	12.4%	0	0	
		1997	23.0%	0	0	
		1998	20.0%	0	0	
Minimum total annual takes						0

[1] Only 1997-98 mortality estimates are included in the average because overall cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico 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 2700, 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.).

STATUS OF STOCK

The status of striped dolphins in California relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet information only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 is zero. Because recent mortality is zero, striped dolphins are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

REFERENCES

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. Admin. Rep. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25p.

Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20 pp.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-233. 15 pp.

Cameron, G., and K. A. Forney. 1999. 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.

Forney, K. A. 1997. Patterns of variability and environmental models of relative abundance for California cetaceans. Ph.D. dissertation, Scripps Institution of Oceanography, University of California, San Diego.

Forney, K. A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-92. Mar. Mamm. Sci. 14:460-489.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

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 mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins and porpoises of the eastern North Pacific and adjacent Arctic waters. A guide to their identification. NOAA Tech. Rep. NMFS Circular 444, U.S. Dep. Commer., NOAA, NMFS. 245 pp.

Mangels, K. F. and Gerrodette, T. 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and Gulf of California aboard the NOAA ships *McARTHUR* and *DAVID STARR JORDAN* July 28 - November 6, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-211. 88 pp.

Perrin, W. F., M. D. Scott, G. J. Walker and V. L. Cass. 1985. Review of geographical stocks of tropical dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern Pacific. NOAA Tech. Rep. NMFS 28. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038. 28p.

Roemmich, D. 1992. Ocean warming and sea level rise along the southwest U.S. coast. Science 257:373-375.

Smith, R. C., P. Dustan, D. Au, K. S. Baker, and E. A. Dunlap. 1986. Distribution of cetaceans and sea-surface chlorophyll concentrations in the California Current. Marine Biology 91:385-402.

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 R. P. 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.

Revised 12/15/2000

SHORT-BEAKED COMMON DOLPHIN (*Delphinus delphis*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Short-beaked common dolphins are the most abundant cetacean off California, and are widely distributed between the coast and at least 300 nmi distance from shore. The abundance of this species off California has been shown to change on both seasonal and inter-annual time scales (Dohl et al. 1986; Barlow 1995; Forney et al. 1995). Historically, they were reported primarily south of Pt. Conception (Dohl et al. 1986), but on recent (1991/93/96) summer/fall surveys, they were commonly sighted as far north as 42°N (Figure 1). Four strandings of common dolphins have been reported in Oregon and Washington since 1942 (B. Norberg, pers. comm.). Of these, three were not identified to the species level, and one animal, which stranded in 1983, was identified as a short-beaked common dolphin (J. Hodder, pers. comm.). Significant seasonal shifts in the abundance and distribution of common dolphins have been identified based on winter/spring 1991-92 and summer/fall 1991 surveys (Forney and Barlow 1998). Their distribution is continuous southward into Mexican waters to about 13°N (Perrin et al. 1985; Wade and Gerrodette 1993; Mangels and Gerrodette 1994), and short-beaked common dolphins off California may be an extension of the "northern common dolphin" stock defined for management of eastern tropical Pacific tuna fisheries (Perrin et al. 1985). However, preliminary data on variation in dorsal fin color patterns suggest there may be multiple stocks in this region, including at least two possible stocks in California (Farley 1995). The less abundant long-beaked common dolphin has only recently been recognized as a different species (Heyning and Perrin 1994; Rosel et al. 1994), and much of the available information has not differentiated between the two types of common dolphin. Although short-beaked common dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Under the Marine Mammal Protection Act (MMPA), short-beaked common dolphins involved in tuna purse seine fisheries in international waters of the eastern tropical Pacific are managed separately, and they are not included in the assessment reports. For the MMPA stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of California, Oregon and Washington.

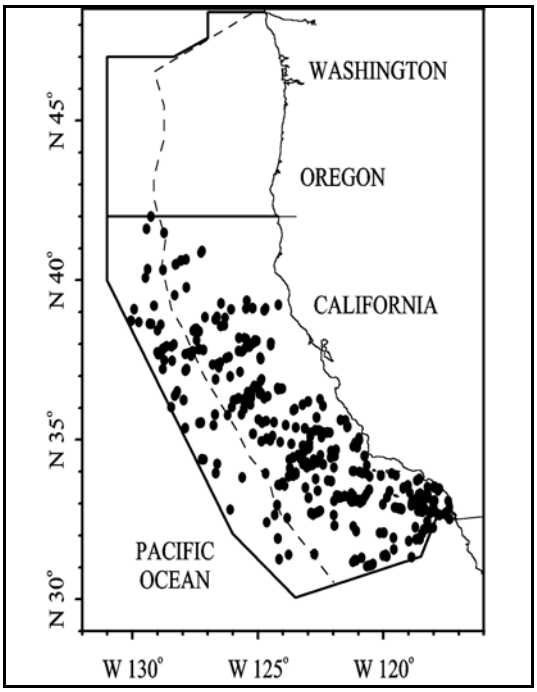

Figure 1. Short-beaked common dolphin sightings based on shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 3-5, for data sources and information on timing and location of survey effort). No *Delphinus* sightings have been made off Oregon and Washington. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Aerial line transect surveys conducted in winter/spring of 1991-92 resulted only in a combined abundance estimate of 305,694 (CV=0.34) animals for short-beaked and long-beaked common dolphins, because species-level identification was not possible from the air (Forney et al. 1995). Based on sighting locations, the majority of these were probably short-beaked common dolphins. A better, species-specific abundance estimate is available based on three summer/fall shipboard surveys that were conducted within 300 nmi of the coasts of California (in 1991 and 1993; Barlow and Gerrodette 1996) and California, Oregon and Washington (in 1996; Barlow 1997). The distribution of short-beaked common dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and interannual time scales (Heyning and Perrin 1994; Forney 1997; Forney and Barlow 1998). As oceanographic conditions vary, short-beaked common dolphins may spend time outside the U.S. Exclusive

Economic Zone, and therefore a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 373,573 (CV=0.19) short-beaked common dolphins (Barlow 1997).

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 318,795 short-beaked common dolphins.

Current Population Trend

In the past, common dolphin abundance has been shown to increase off California during the warm-water months (Dohl et al. 1986). Surveys conducted during both cold-water and warm-water conditions in 1991 and 1992 (Barlow 1995, Forney et al. 1995) resulted in overall abundance estimates (for both types of common dolphins combined) which were considerably greater than historical estimates (Dohl et al. 1986). The recent combined abundance estimate for the 1991-96 summer/fall surveys (Barlow 1997) is the highest and most precise to date. Environmental models (Forney 1997) and seasonal comparisons (Forney and Barlow 1998) have shown that the abundance of short-beaked common dolphins off California varies with seasonal and interannual changes in oceanographic conditions. An ongoing decline in the abundance of 'northern common dolphins' (including both long-beaked and short-beaked common dolphins) in the eastern tropical Pacific and along the Pacific coast of Mexico suggests a possible northward shift in the distribution of common dolphins (IATTC 1997) during this period of gradual warming of the waters off California (Roemmich 1992). The majority of this is likely to reflect an increase in the abundance of short-beaked common dolphins. Heyning and Perrin (1994) have detected changes in the proportion of short-beaked to long-beaked common dolphins stranding along the California coast, with the short-beaked common dolphin stranding more frequently prior to the 1982-83 El Niño (which increased water temperatures off California), and the long-beaked common dolphin more commonly observed for several years afterwards. Thus, it appears that both relative and absolute abundances of these species off California may change with varying oceanographic conditions.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of current or maximum net productivity rates for short-beaked common dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (318,795) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with a mortality rate CV< 0.30; Wade and Angliss 1997), resulting in a PBR of 3,188 short-beaked common dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for short-beaked common dolphins is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality of common dolphins primarily has been observed in California drift gillnet fisheries (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). Because of the difficulty in distinguishing short-beaked and long-beaked common dolphins in the field, tissue samples have been collected for most of the animals observed killed. These tissue samples have enabled positive identification using genetic techniques for all except two of the common dolphins killed (NMFS, unpublished data). Based on past patterns (Barlow et al. 1997), these two animals are likely to have been a short-beaked common dolphin, and they are included below for this species. 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, common dolphin entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 1999). However, because of interannual variability in entanglement rates additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this species in the long term. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 78 (CV=0.23) short-beaked common dolphins taken annually.

Table 1. Summary of available information on the incidental mortality and injury of short-beaked common dolphins

(California/Oregon/Washington Stock), in commercial fisheries that might take this species. All entanglements resulted in the death of the animal. The observer program for the set gillnet fishery was discontinued during 1994. Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9% 15.6% 12.4% 23.0% 20.0%	26 36 27 21 9	146 (0.18) 231 (0.29) 319 (0.23) 105 (0.30) 51 (0.33)	(includes prorated) 78 (0.23)[1]
CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery	observer data	Common dolphins, species not determined				
		1994 1995-98	7.7% 0%	0 n/a	0 n/a	n/a
	MMAP self-reporting	1995 1996 1998	- - -	1 1 2	$\geq$ 1 $\geq$ 1 $\geq$ 2	$\geq$ 0.8 (n/a)
Undetermined	strandings	1994-98	2 common dolphins (species not determined) stranded with evidence of fishery interactions			$\geq$ 0.4 (n/a)
Minimum total annual takes						79 (0.23)

[1]Only 1997-98 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). Following these changes in the fishery, entanglement rates of short-beaked common dolphin declined.

Additional common dolphin mortality has been reported for set gillnets in California (Julian and Beeson 1998); however, because of a 1994 ban on gillnets in nearshore areas of Southern California, the size of this fishery decreased by about a factor of two (see Appendix 1), and the observer program was discontinued. No observer data are available for the set gillnet fishery after 1994, but Marine Mammal Authorization Permit (MMAP) fisher self-reports for 1994-98 indicate that at least four common dolphins (type not specified) were killed between 1995 and 1998. Although these reports are considered unreliable (see Appendix 4 of Hill and DeMaster 1998) they represent a minimum mortality for this fishery.

Two common dolphins (type not specified) stranded with evidence of fishery interaction (NMFS, Southwest Region, unpublished data); one animal had a hook and line in its mouth and a slit ventrum, and the other animal had its flukes cut off. It is not known which fisheries were responsible for these deaths.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, probably take short-beaked common dolphins 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 2700, 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.).

Other Mortality

In the eastern tropical Pacific, 'northern common dolphins' have been incidentally killed in international tuna purse seine fisheries since the late 1950's. Cooperative international management programs have dramatically reduced overall dolphin mortality in these fisheries during the last decade (Joseph 1994). Between 1994 and 1998, annual mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between 9 and 261 animals, with an average of 91 (IATTC, in prep). Although it is unclear whether these animals are part of the same population as short-beaked common dolphins found off California, they are managed separately under a section of the MMPA written specifically for the management of dolphins involved in eastern tropical Pacific tuna fisheries.

STATUS OF STOCK

The status of short-beaked common dolphins in Californian waters relative to OSP is not known. The observed increase in abundance of this species off California over the last decade probably reflects a distributional shift (Anganuzzi et al. 1993; Barlow 1995; Forney et al. 1995; Forney and Barlow 1998), rather than an overall population increase due to growth. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 (79 animals) is estimated to be less than the PBR (3,188), and therefore they are not classified as a "strategic" stock under the MMPA. The total estimated fishery mortality and injury for short-beaked common dolphins is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Anganuzzi, A. A., S. T. Buckland, and K. L Cattanach. 1993. Relative abundance of dolphins associated with tuna in the eastern tropical Pacific Ocean: analysis of 1991 data. Rep. Int. Whal. Commn 43:459-465.

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. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 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 T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-233.

Dohl, T. P., M. L. Bonnell, and R. G. Ford. 1986. Distribution and abundance on common dolphin, *Delphinus delphis*, in the Southern California Bight: A quantitative assessment based upon aerial transect data. Fish. Bull. 84:333-343.

Farley, T. D. 1995. Geographic variation in dorsal fin color of short-beaked common dolphins, *Delphinus delphis*, in the eastern Pacific Ocean. Administrative Report LJ-95-06, Available from National Marine Fisheries Service, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038.

Forney, K. A. 1997. Patterns of variability and environmental models of relative abundance for California cetaceans. Ph.D. Dissertation, Scripps Institution of Oceanography, University of California, San Diego.

Forney, K. A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-92. Mar. Mamm. Sci. 14:460-489.

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.

Heyning, J. E. and W. F. Perrin. 1994. Evidence for two species of common dolphins (Genus *Delphinus*) from the eastern North Pacific. Contr. Nat. Hist. Mus. L.A. County, No. 442.

Hill, P. S. and D. P. DeMaster. 1998. Alaska Marine Mammal Stock Assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-97. 166pp.

Hodder, J. Oregon Institute of Marine Biology, Charleston, OR, 97420.
Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.
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 p.
IATTC. 1997. Annual Report of the Inter-American Tropical Tuna Commission, 1995, La Jolla, California.
IATTC. (in prep). Annual Report of the Inter-American Tropical Tuna Commission, 1998, La Jolla, California.
Joseph, J. 1994. The tuna-dolphin controversy in the eastern Pacific Ocean: biological, economic and political impacts. Ocean Dev. Int. Law 25:1-30.
Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 1997 (unpublished). 13 pp.
Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.
Mangels, K. F. and Gerrodette, T. 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and Gulf of California aboard the NOAA ships *McARTHUR* and *DAVID STARR JORDAN* July 28 - November 6, 1993. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-211.
NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-027.
NMFS, Southwest Region, 501 West Ocean Blvd, Long Beach, CA 90802-4213.
Norberg, B., NMFS, Northwest Region,.7600 Sand Point Way NE, BIN C15700,Seattle, WA 98115-0070.
Perrin, W. F., M. D. Scott, G. J. Walker and V. L. Cass. Review of geographical stocks of tropical dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern Pacific. NOAA Technical Report NMFS 28. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038. 28p.
Roemmich, D. 1992. Ocean warming and sea level rise along the southwest U.S. coast. Science 257:373-375.
Rosel, P. E., A. E. Dizon and J. E. Heyning. 1994. Population genetic analysis of two forms of the common dolphin (genus *Delphinus*) utilizing mitochondrial DNA control region sequences. Marine Biology 119:159-167.
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 R. P. 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.
Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn 43:477-493.

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LONG-BEAKED COMMON DOLPHIN (*Delphinus capensis*): California Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Long-beaked common dolphins have only recently been recognized as a distinct species (Heyning and Perrin 1994; Rosel et al. 1994). Along the U.S. west coast, their distribution overlaps with that of the short-beaked common dolphin, and much historical information has not distinguished between these two species. Long-beaked common dolphins are commonly found within about 50 nmi of the coast, from Baja California (including the Gulf of California) northward to about central California (Figure 1). Stranding data and sighting records indicate that the relative abundance of this species off California changes both seasonally and inter-annually, with highest densities observed during warm-water events (Heyning and Perrin 1994). Although long-beaked common dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Under the Marine Mammal Protection Act (MMPA), long-beaked ("Baja neritic") common dolphins involved in eastern tropical Pacific tuna fisheries are managed separately as part of the 'northern common dolphin' stock (Perrin et al. 1985), and these animals are not included in the assessment reports. For the MMPA stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of California.

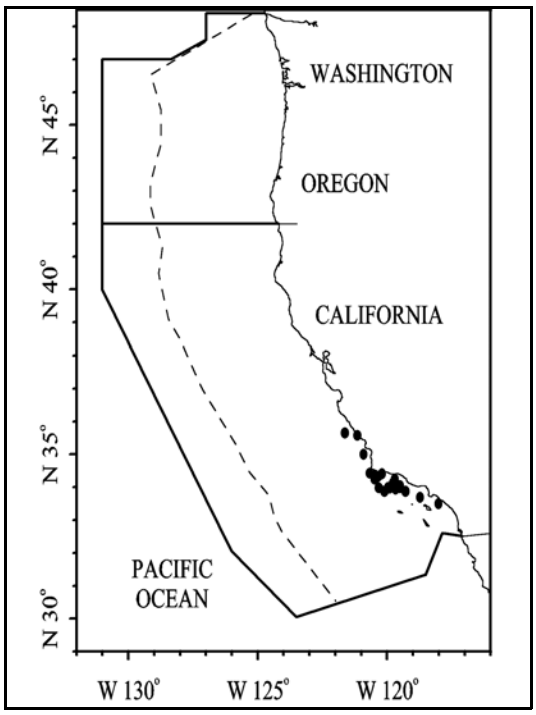

Figure 1. Long-beaked common dolphin sightings based on shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 3-5, for data sources and information on timing and location of survey effort). No *Delphinus* sightings have been made off Oregon and Washington. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Aerial line transect surveys conducted in winter and spring of 1991 and 1992 resulted only in a combined abundance estimate of 305,694 (CV=0.34) long-beaked and short-beaked common dolphins, because species-level identification was not possible from the air (Forney et al. 1995). Based on sighting locations, the majority of these animals were probably short-beaked common dolphins. A better, species-specific abundance estimate is available based on three summer/fall shipboard surveys that were conducted within 300 nmi of the coasts of California (in 1991 and 1993; Barlow and Gerrodette 1996) and California, Oregon and Washington (in 1996; Barlow 1997). The distribution and abundance of long-beaked common dolphins off California appears to be variable on interannual and seasonal time scales (Heyning and Perrin 1994). As oceanographic conditions change, long-beaked common dolphins may spend time in Mexican waters, and therefore a multi-year average abundance estimate is the most appropriate for management within the U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 32,239 (CV=0.18) long-beaked common dolphins (Barlow 1997).

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 27,739 long-beaked common dolphins.

Current Population Trend

Due to the historical lack of distinction between the two species of common dolphins, it is difficult to establish trends in abundance for this species. In the past, common dolphins have been shown to increase in abundance off California during the warm-water months (Dohl et al. 1986). Surveys conducted during both cold-water and warm-water conditions in 1991 and 1992 (Barlow 1995, Forney et al. 1995) resulted in overall abundance estimates (for both types of common dolphins combined) which were considerably greater than historical estimates (Dohl et al. 1986). The combined abundance estimate for the 1991-96 summer/fall surveys (Barlow 1997) is the highest and most precise to date. An ongoing decline in the abundance of 'northern common dolphins' (including both long-beaked and short-beaked common dolphins) in the eastern tropical Pacific and along the Pacific coast of Mexico (IATTC 1997) suggests a possible northward shift in the distribution of common dolphins during this period of gradual warming of the waters off California (Roemmich 1992). However, it is unclear how much of this increase reflects an increase in the abundance of the long-beaked common dolphin. Heyning and Perrin (1994) have detected changes in the proportion of short-beaked to long-beaked common dolphins stranding along the California coast, with the short-beaked common dolphin stranding more frequently prior to the 1982-83 El Niño (which increased water temperatures off California), and the long-beaked common dolphin more commonly observed for several years afterwards. Thus, it appears that both relative and absolute abundance of these species off California may change with varying oceanographic conditions.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of current or maximum net productivity rates for long-beaked common dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (27,629) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.45 (for a species of unknown status with a mortality rate CV $\geq$ 0.60 and $\leq$ 0.80; Wade and Angliss 1997), resulting in a PBR of 250 long-beaked common dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for long-beaked common dolphins is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality of common dolphins primarily has been observed in California drift gillnet fisheries (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999). Because of the difficulty in distinguishing short-beaked and long-beaked common dolphins in the field, tissue samples have been collected for most of the animals observed killed. These tissue samples have enabled positive identification using genetic techniques for all except two of the common dolphins killed (NMFS, unpublished data). Based on past patterns (Barlow et al. 1997), these two animals are likely to have been a short-beaked common dolphin, and they have not been included in the mortality calculations below for long-beaked common dolphins. 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, common dolphin entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 1999). However, because of interannual variability in entanglement rates additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this species in the long term. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 13 (CV=0.74) long-beaked common dolphins taken annually.

Additional common dolphin mortality has been reported for set gillnets in California (Julian and Beeson 1998); however, because of a 1994 ban on gillnets in nearshore areas of Southern California, the size of this fishery decreased by about a factor of two (see Appendix 1), and the observer program was discontinued. No observer data are available for the set gillnet fishery after 1994, but Marine Mammal Authorization Permit (MMAP) fisher self-reports for 1994-98 indicate that at least four common dolphins (type not specified) were killed between 1995 and 1998. Although these reports are considered unreliable (see Appendix 4 of Hill and DeMaster 1998) they represent a minimum mortality for this fishery.

Two common dolphins (type not specified) stranded with evidence of fishery interaction (NMFS, Southwest Region, unpublished data); one animal had a hook and line in its mouth and a slit ventrum, and the other animal had its flukes cut off. It is not known which fisheries were responsible for these deaths.

Table 1. Summary of available information on the incidental mortality and injury of long-beaked common dolphins (California Stock) and prorated unidentified common dolphins in commercial fisheries that might take this species. All observed entanglements resulted in the death of the animal. The observer program for the set gillnet fishery was discontinued during 1994. Coefficients of variation for mortality estimates are provided in parentheses, when available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9% 15.6% 12.4% 23.0% 20.0%	1 6 1 4 0	6 (0.91) 39 (0.65) 12 (0.96) 25 (0.74) 0	13 (0.74)[1]
CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery		Common dolphins, species not determined				n/a
	observer data	1994 1995-98	7.7% 0%	0 n/a	0 n/a	
	MMAP self-reporting	1995 1996 1998	- - -	1 1 2	$\geq$ 1 $\geq$ 1 $\geq$ 2	$\geq$ 0.8 (n/a)
Undetermined	strandings	1994-98	2 common dolphins (species not determined) stranded with evidence of fishery interactions			$\geq$ 0.4 (n/a)
Minimum total annual takes						14 (0.74)

[1]Only 1997-98 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. Following these changes in the fishery, entanglement rates of long-beaked common dolphin declined.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take long-beaked common dolphins 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 2700, 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.).

Other Mortality

In the eastern tropical Pacific, 'northern common dolphins' have been incidentally killed in international tuna purse seine fisheries since the late 1950's. Cooperative international management programs have dramatically reduced overall dolphin mortality in these fisheries during the last decade (Joseph 1994). Between 1994 and 1998, annual mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between 9 and 261 animals, with an average of 91 (IATTC, in prep). Although it is likely that the long-beaked common dolphins included in the 'northern common dolphin' stock are part of the same population as those found off California, they are managed separately under a section of the MMPA written specifically for the management of dolphins involved in eastern tropical Pacific tuna fisheries.

STATUS OF STOCK

The status of long-beaked common dolphins in California waters relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance of this species of common dolphin. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 (14 animals) is estimated to be less than the PBR (250), and therefore they are not classified as a "strategic" stock under the MMPA. The average total fishery mortality and injury for long-beaked common dolphins is less than 10% of the PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

REFERENCES

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. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 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 T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-233.

Cameron, G., and K. A. Forney. 1999. Estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, 1999 (unpublished). 14pp.

Dohl, T. P., M. L. Bonnell, and R. G. Ford. 1986. Distribution and abundance on common dolphin, *Delphinus delphis*, in the Southern California Bight: A quantitative assessment based upon aerial transect data. Fish. Bull. 84:333-343.

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.

Heyning, J. E. and W. F. Perrin. 1994. Evidence for two species of common dolphins (Genus *Delphinus*) from the eastern North Pacific. Contr. Nat. Hist. Mus. L.A. County, No. 442.

Hill, P. S. and D. P. DeMaster. 1998. Alaska Marine Mammal Stock Assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-97. 166 pp.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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.

IATTC. 1997. Annual Report of the Inter-American Tropical Tuna Commission, 1995, La Jolla, California.

IATTC. (in prep). Annual Report of the Inter-American Tropical Tuna Commission, 1998, La Jolla, California.

Joseph, J. 1994. The tuna-dolphin controversy in the eastern Pacific Ocean: biological, economic and political impacts. Ocean Dev. Int. Law 25:1-30.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 1997 (unpublished). 13 pp.

Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-027.

NMFS, Southwest Region, 501 West Ocean Blvd, Long Beach, CA 90802-4213.

Perrin, W. F., M. D. Scott, G. J. Walker and V. L. Cass. Review of geographical stocks of tropical dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern Pacific. NOAA Technical Report NMFS 28. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038. 28p.

Roemmich, D. 1992. Ocean warming and sea level rise along the southwest U.S. coast. Science 257:373-375.
Rosel, P. E., A. E. Dizon and J. E. Heyning. 1994. Population genetic analysis of two forms of the common dolphin (genus *Delphinus*) utilizing mitochondrial DNA control region sequences. Marine Biology 119:159-167.
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 R. P. 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.

Revised 12/15/2000

NORTHERN RIGHT-WHALE DOLPHIN (*Lissodelphis borealis*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern right-whale dolphins are endemic to temperate waters of the North Pacific Ocean. Off the U.S. west coast, they have been seen primarily in shelf and slope waters (Figure 1), with seasonal movements into the Southern California Bight (Leatherwood and Walker 1979; Dohl et al. 1980; 1983; NMFS, unpublished data). Sighting patterns from recent aerial and shipboard surveys conducted in California, Oregon and Washington during different seasons (Green et al. 1992; 1993; Forney et al. 1995; Barlow 1995) suggest seasonal north-south movements, with animals found primarily off California during the colder water months and shifting northward into Oregon and Washington as water temperatures increase in late spring and summer (Green et al. 1992; Forney 1994; Forney and Barlow 1998). The southern end of this population's range is not well-documented, but during cold-water periods, they probably range into Mexican waters off northern Baja California. Genetic analyses have not found statistically significant differences between northern right-whale dolphins from the U.S. West coast and other areas of the North Pacific (Dizon et al. 1994); however, power analyses indicate that the ability to detect stock differences for this species is poor, given traditional statistical error levels (Dizon et al. 1995). Although northern right-whale dolphins are not restricted to U.S. territorial waters, there are currently no international agreements for cooperative management. For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single management stock including only animals found within the U.S. Exclusive Economic Zone of California, Oregon and Washington.

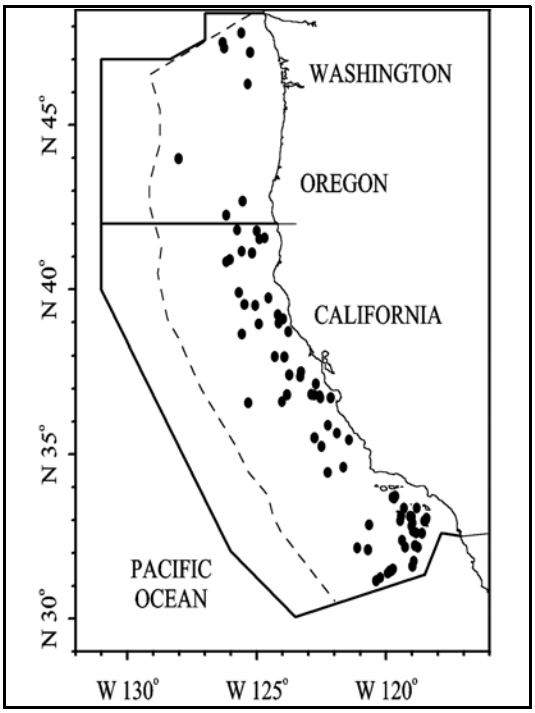

Figure 1. Northern right-whale dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

The previous best estimates of abundance for northern right-whale dolphins (Barlow et al. 1997) were based on winter/spring 1991-92 aerial surveys (Forney et al. 1995) off California, which were presumed to include northern right-whale dolphins that are found off Oregon and Washington during summer and fall. Three summer/fall shipboard surveys were conducted within 300 nmi of the coasts of California in 1991 and 1993 (Barlow and Gerrodette 1996) and California, Oregon and Washington in 1996 (Barlow 1997). The distribution of northern right-whale dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and interannual time scales (Forney and Barlow 1998). As oceanographic conditions vary, northern right-whale dolphins may spend time outside the U.S. Exclusive Economic Zone, and therefore a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the three ship surveys is 13,705 (CV=0.38) northern right-whale dolphins (Barlow 1997).

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 10,060 northern right-whale dolphins.

Current Population Trend

No information is available regarding trends in abundance of northern right-whale dolphins in California, Oregon and Washington.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for northern right-whale dolphins off the U.S. west coast.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (10,060) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.48 (for a species of unknown status with a mortality rate CV>0.30; Wade and Angliss 1997), resulting in a PBR of 97 northern right-whale dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for this stock of northern right-whale dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the relative rarity of northern right-whale dolphin entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 15 (CV=0.42) northern right-whale dolphins taken annually.

Table 1. Summary of available information on the incidental mortality and injury of northern right-whale dolphins (California/Oregon/Washington Stock) in commercial fisheries that might take this species. All observed entanglements of northern right-whale dolphins resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9% 15.6% 12.4% 23.0% 20.0%	7 9 5 5 0	39 (0.42) 58 (0.59) 27 (0.68) 29 (0.42) 0	15 (0.42)[1]
Minimum total annual takes						15 (0.42)

[1]Only 1997-98 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). Following these changes within the fishery, entanglement rates of northern right-whale dolphin declined.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population during cold-water periods. 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 2700, 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.).

STATUS OF STOCK

The status of northern right-whale dolphins in California, Oregon and Washington relative to OSP is not known, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 (15 animals) is estimated to be less than the PBR (97), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for northern right-whale dolphins is greater than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.

REFERENCES

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. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 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 T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-233.

Cameron, G., and K. A. Forney. 1999. Estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, 1999 (unpublished). 14pp.

Dizon, A., C. LeDuc, and R. LeDuc. 1994. Intraspecific structure of the northern right-whale dolphin (*Lissodelphis borealis*): The power of an analysis of molecular variation for differentiating genetic stocks. CalCOFI Rep. 35:61-67.

Dizon, A. E., G. M. O'Corry-Crowe, and B. L. Taylor. (1995). Why statistical power is necessary to link analyses of molecular variation to decisions about population structure. pp. 288-294 *In:* J. L. Neilsen (ed.), Evolution and the Aquatic Ecosystem: Defining Unique Units in Population Conservation. American Fisheries Society Symposium 17.

Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-1983: Status, abundance and distribution. OCS Study MMS 84-0045. Minerals Management Service Contract # 14-12-0001-29090. 284p.

Dohl, T. P., K. S. Norris, R. C. Guess, J. D. Bryant, and M. W. Honig. 1980. Summary of marine mammal and seabird surveys of the Southern California Bight area, 1975-1978. Part II. Cetacea of the Southern California Bight. Final Report to the Bureau of Land Management, NTIS Rep. No. PB81248189. 414p.

Forney, K. A. 1994. Recent information on the status of odontocetes in Californian waters. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-202. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, USA.

Forney, K. A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-92. Mar. Mamm. Sci. 14:460-489.

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.

Green, G., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington. Ch. 1. In: Oregon and Washington Marine Mammal and Seabird Surveys. OCS Study 91-0093. Final Report prepared for Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior, Los Angeles, California.

Green, G., R. A. Grotefendt, M. A. Smultea, C. E. Bowlby, and R. A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington waters. Final Report prepared for NMFS, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, Washington, 98115, Contract #50ABNF200058.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.
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 p.
Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 1997 (unpublished). 13 pp.
Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.
Leatherwood, S. and W. A. Walker. 1979. The northern right-whale dolphin *Lissodelphis borealis* Peale in the eastern North Pacific. *In:* Winn, H. E. and B. L. Olla (eds.), Behavior of Marine Mammals, p. 85-141. Plenum Press, New York - London.
National Marine Fisheries Service, Southwest Fisheries Science Center. Unpublished data.
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.
Stick, K. C. and Hreha, L. 1989. Summary of the 1988 Washington/Oregon experimental thresher shark gill net fishery. State of Washington, Department of Fisheries, Progress Report 275. 40p.
Wade, P. R. and R. P. 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.

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KILLER WHALE (*Orcinus orca*): Eastern North Pacific Offshore Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where pods have been labeled as 'resident', 'transient' and 'offshore' (Bigg et al. 1990, Ford et al. 1994) based on aspects of morphology, ecology, genetics and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992, Hoelzel et al. 1998). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Heise et al. 1991) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994).

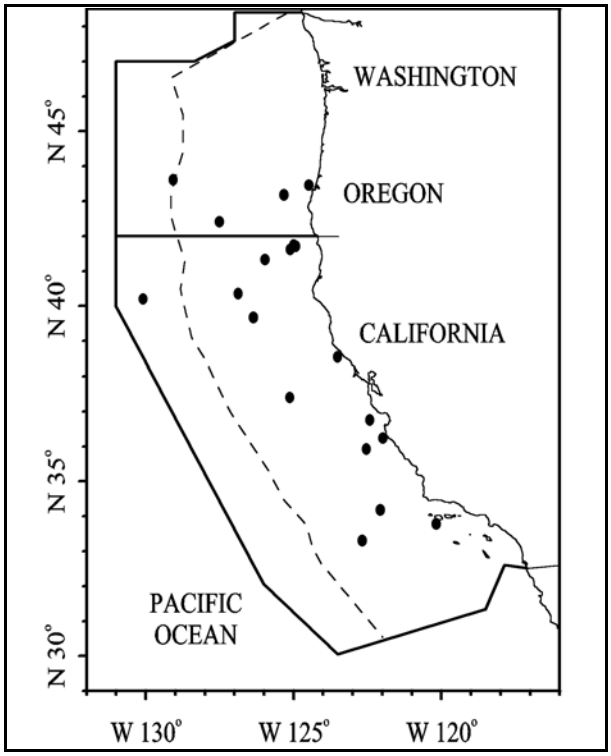

Figure 1. Killer whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Sightings include killer whales from all stocks found in this region. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

Offshore killer whales have more recently also been identified off the coasts of California, Oregon, and rarely, in Southeast Alaska (Ford et al. 1994, Black et al. 1997, Dahlheim et al. 1997). They apparently do not mix with the transient and resident killer whale stocks found in these regions (Ford et al. 1994, Black et al. 1997). Studies indicate the 'offshore' type, although distinct from the other types ('resident' and 'transient'), appears to be more closely related genetically, morphologically, behaviorally, and vocally to the 'resident' type killer whales (Black et al. 1997, Hoelzel et al. 1998; J. Ford, pers. comm.; L. Barrett-Lennard, pers. comm.). Based on data regarding association patterns, acoustics, movements, genetic differences, and potential fishery interactions, five killer whale stocks are recognized within the Pacific U.S. EEZ 1) the Eastern North Pacific Northern Resident stock - occurring from British Columbia through Alaska, 2) the Eastern North Pacific Southern Resident stock - occurring within the inland waters of Washington State and southern British Columbia, 3) the Eastern North Pacific Transient stock - occurring from Alaska through California, 4) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California (this report), and 5) the Hawaiian stock. 'Offshore' whales in Canadian waters are considered part of the Eastern North Pacific Offshore stock. The Stock Assessment Reports for the Alaska Region contain assessments of the Eastern North Pacific Northern Resident stock, and the most recent assessment for the Hawaii Stock is included in this volume.

POPULATION SIZE

Off British Columbia, approximately 200 offshore killer whales were identified between 1989 and 1993 (Ford et al. 1994), and 20 of these individuals have also been seen off California (Black et al. 1997). Using only good quality photographs that clearly show characteristics of the dorsal fin and saddle patch region, an additional 11 offshore killer whales that were not previously known have been identified off the California coast, bringing the total number of known individuals in this population to 211. This is certainly an underestimate of the total population size, because not all animals in this population have been photographed. In the future, it may be possible estimate the total abundance of this transboundary stock using mark-recapture analyses based on individual photographs. Based on summer/fall shipboard line-transect surveys in 1991, 1993 and 1996 (Barlow 1997), the total number of killer whales within 300 nmi of the coasts of California, Oregon and Washington was recently estimated to be 819 animals (CV=0.38). There is currently no way to reliably distinguish the different stocks of killer whales from sightings at sea, but photographs of individual animals can provide a rough estimate of the proportion of whales in each stock. A total of 161 individual killer whales photographed off California and Oregon have been determined to belong to the transient (105 whales) and offshore (56 whales) stocks (Black et al. 1997). Using these proportions to prorate the line transect abundance estimate yields an estimate of 56/161 * 819 = 285 offshore killer whales along the U.S. west coast. This is expected to be a conservative estimate of the number of offshore killer whales, because offshore whales apparently are less frequently seen near the coast (Black et al. 1997), and therefore photographic sampling may be biased towards transient whales. For stock assessment purposes, this combined value is currently the best available estimate of abundance for offshore killer whales off the coasts of California, Oregon and Washington.

Minimum Population Estimate

The total number of known offshore killer whales along the U.S. West coast, Canada and Alaska is 211 animals, but it is not known what proportion of time this transboundary stock spends in U.S. waters, and therefore this number is difficult to work with for PBR calculations. A minimum abundance estimate for all killer whales along the coasts of California, Oregon and Washington can be estimated from the 1991-1996 line-transect surveys as the 20th percentile of the abundance estimate, or 601 killer whales. Using the same prorating as above, a minimum of 56/161 * 601 = 209 offshore killer whales are estimated to be in U.S. waters off California, Oregon and Washington.

Current Population Trend

No information is available regarding trends in abundance of Eastern North Pacific offshore killer whales.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for killer whales in this region.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (209) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 2.1 offshore killer whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of information on fisheries that may take animals from this killer whale stock is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. In the California drift gillnet fishery, no offshore killer whales have been observed entangled (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999), but one killer whale from the Eastern North Pacific Transient Stock was observed taken in 1995, and offshore killer whales may also occasionally be entangled. Additional potential sources of killer whale mortality are set gillnets and longlines. In California, an observer program between July 1990 and December 1994 monitored 5-15% of all sets in the large mesh (>3.5") set gillnet fishery for halibut and angel sharks, and no killer whales were observed taken. Based on observations for longline fisheries in other regions (i.e. Alaska; Yano and Dahlheim 1995), fishery interactions may also occur with U.S. West coast pelagic longline fisheries, but no such interactions have been documented to date.

Table 1. Summary of available information on the incidental mortality and injury of killer whales (Eastern North

Pacific Offshore Stock) in commercial fisheries that might take this species. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9% 15.6% 12.4% 23.0% 20.0%	0 0 0 0 0	0 0 0 0 0	0[1]
Minimum total annual takes						0

[1] Only 1997-98 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).

Set and drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico 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 2700, 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.).

Historical mortality

California coastal whaling operations killed five killer whales between 1962 and 1967 (Rice 1974). An additional killer whale was taken by whalers in British Columbian waters (Hoyt 1981). It is unknown whether any of these animals belonged to the Eastern North Pacific Offshore stock.

STATUS OF STOCK

The status of killer whales in California in relation to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. There has been no documented human-caused mortality of this stock, and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for offshore killer whales is zero and can be considered to be insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Baird, R. W., and P. J. Stacey. 1988. Variation in saddle patch pigmentation in populations of killer whales (*Orcinus orca*) from British Columbia, Alaska, and Washington State. Can. J. Zool. 66:2582-2585.

Baird, R. W., Abrams, P. A., and L. M. Dill. 1992. Possible indirect interactions between transient and resident killer whales: implications for the evolution of foraging specializations in the genus *Orcinus*. Oecologia 89:125-132.

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., 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. 223 pp.

Barrett-Lennard, L. Univ. of British Columbia, 6270 University Blvd., Vancouver, BC V6T1Z4.

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford, and K. C. Balcomb III. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep. int. Whal. Commn Special Issue 12:386-406.

Black, N. A., A. Schulman-Janiger, R. L. Ternullo, and M. Guerrero-Ruiz. 1997. Killer whales of California and western Mexico: A Catalog of photo-identified individuals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-247. 174p.

Braham, H. W., and M. E. Dahlheim. 1982. Killer whales in Alaska documented in the Platforms of Opportunity Program. Rep. Int. Whal. Commn., 32:643-646.

Cameron, G., and K. A. Forney. 1999. Estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, 1999 (unpublished). 14pp.

Dahlheim, M. E., D. Ellifrit, and J. Swenson. 1997. Killer Whales of Southeast Alaska: A Catalogue of Photoidentified Individuals. Day Moon Press, Seattle, WA. 82 pp. + appendices.

Ford, J. K. B., Vancouver Aquarium, P.O. Box 3232, Vancouver, BC V6B 3XB, Canada.

Ford, J. K. B., G. M. Ellis, and K.C. Balcomb. 1994. Killer whales. The natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. UBC Press, Vancouver, Canada

Ford, J. K. B., and H. D. Fisher. 1982. Killer whale (*Orcinus orca*) dialects as an indicator of stocks in British Columbia. Rep. Int. Whal. Commn 32:671-679.

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.

Goley, P. D., and J. M. Straley. 1994. Attack on gray whales (*Eschrichtius robustus*) in Monterey Bay, California, by killer whales (*Orcinus orca*) previously identified in Glacier Bay, Alaska. Can. J. Zool. 72:1528-1530.

Green, G., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington. Ch. 1. In: Oregon and Washington Marine Mammal and Seabird Surveys. OCS Study 91-0093. Final Report prepared for Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior, Los Angeles, California.

Heise, K., G. Ellis, and C. Matkin. 1991. A catalogue of Prince William Sound Killer Whales. North Gulf Oceanic Society, Homer, AK. Published for the National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Hoelzel, A. R., M. E. Dahlheim, and S. J. Stern. 1998. Low genetic variation among killer whales (*Orcinus orca*) in the Eastern North Pacific, and genetic differentiation between foraging specialists. J. Heredity 89:121-128.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

Hoyt, E. 1981. The Whale Called Killer. E. P. Dutton, New York.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 1997 (unpublished). 13 pp.

Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fishery Bulletin 96:271-284.

Leatherwood, J. S., and M. E. Dahlheim. 1978. Worldwide distribution of pilot whales and killer whales. Naval Ocean Systems Center, Tech. Rep. 443:1-39.

Leatherwood, S., C. O. Matkin, J. D. Hall, and G. M. Ellis. 1990. Killer whales, *Orcinus orca*, photo-identified in Prince William Sound, Alaska 1976 to 1987. Can. Field Naturalist 104:362-371.

Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Board Canada, 32:914-916.

Rice, D. W. 1974. Whales and whale research in eastern North Pacific. p. 170-195 *In:* W. E. Schevill (ed.), The Whale Problem - A Status Report. Harvard University Press, Cambridge, MA.

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.

Yano, K. and M. E. Dahlheim. 1995. Killer whale, *Orcinus orca*, depredation on longline catches of bottomfish in the southeastern Bering Sea and adjacent waters. Fishery Bulletin 93:355-372.

Wade, P. R. and R. P. 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.

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KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where pods have been labeled as 'resident,' 'transient,' and 'offshore' (Bigg et al. 1990, Ford et al. 1994) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982, Baird and Stacey 1988, Baird et al. 1992, Hoelzel et al. 1998). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Matkin et al. 1999) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997).

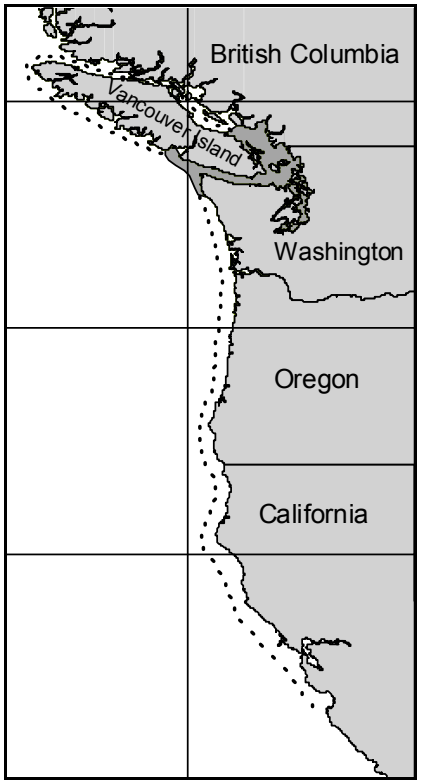

Figure 1. Approximate April-October distribution of the Eastern North Pacific Southern Resident killer whale stock (shaded area) and range of sightings (dotted line).

Studies on mtDNA restriction patterns provide evidence that the 'resident' and 'transient' types are genetically distinct (Stevens et al. 1989, Hoelzel 1991, Hoelzel and Dover 1991, Hoelzel et al. 1998). Analysis of 73 samples collected from eastern North Pacific killer whales from California to Alaska has demonstrated significant genetic differences among 'transient' whales from California through Alaska, 'resident' whales from the inland waters of Washington, and 'resident' whales ranging from British Columbia to the Aleutian Islands and Bering Sea (Hoelzel et al. 1998). Most sightings of the Eastern North Pacific Southern Resident stock of killer whales have occurred in the summer in inland waters of Washington and southern British Columbia. However, pods belonging to this stock have also been sighted in coastal waters off southern Vancouver Island and Washington (Bigg et al. 1990, Ford et al. 2000). The complete winter range of this stock is uncertain. Of the three pods comprising this stock, one (J1) is commonly sighted in inshore waters in winter, while the other two (K1 and L1) apparently spend more time offshore (Ford et al. 2000). Pods K1 and L1 are often seen entering the inland waters of Vancouver Island from the north--through Johnstone Strait--in the spring (Ford et al. 2000), suggesting that they may spend time along the entire outer coast of Vancouver Island during the winter. Off the Washington coast, Southern Resident killer whales have been sighted as far south as Grays Harbor (season unknown) (Bigg et al. 1990), and members of pods K1 and L1were observed in Monterey Bay, California, in January 2000 (N. Black, pers. comm.).

Based on data regarding association patterns, acoustics, movements, genetic differences and potential fishery interactions, five killer whale stocks are recognized within the Pacific U.S. EEZ: 1) the Eastern North Pacific Northern Resident stock - occurring from British Columbia through Alaska, 2) the Eastern North Pacific Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia (see Fig. 1), 3) the Eastern North Pacific Transient stock - occurring from Alaska through California, 4) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California, and 5) the Hawaiian stock. The Stock Assessment Reports for the Alaska Region contain information concerning the Eastern North Pacific Northern Resident stock.

POPULATION SIZE

The Eastern North Pacific Southern Resident stock is a trans-boundary stock including killer whales in inland Washington and southern British Columbia waters. Photo-identification of individual whales through the years has resulted in a substantial understanding of this stock's structure, behaviors, and movements. In 1993, the three pods comprising this stock totaled 96 killer whales (Ford et al. 1994). The population increased to 99 whales in 1995, then declined to the current population of 82 whales in 2000 (Fig. 2; Ford et al. 2000; Center for Whale Research, unpubl. data).

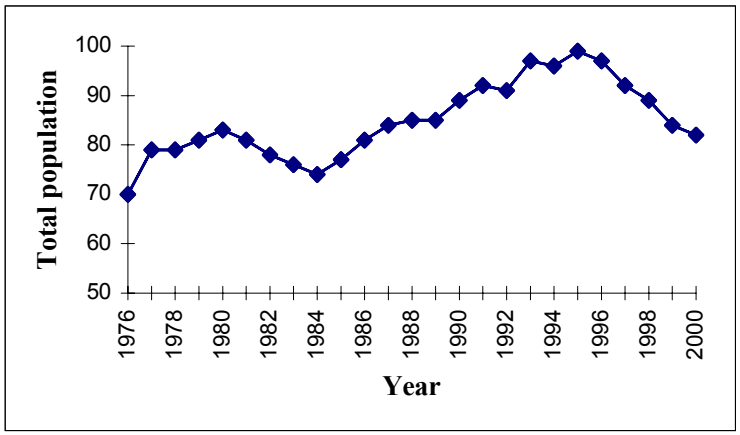

Figure 2. Population of Eastern North Pacific Southern Resident stock of killer whales 1976-2000. Each year's count includes animals first seen and first missed; a whale is considered first missed the year after it was last seen alive (Ford et al. 2000; Center for Whale Research, unpubl. data).

Minimum Population Estimate

The abundance estimate for this stock of killer whales is a direct count of individually identifiable animals. It is thought that the entire population is censused every year. This estimate therefore serves as both a best estimate of abundance and a minimum estimate of abundance. Thus, the minimum population estimate (N_{MIN}) for the Eastern North Pacific Southern Resident stock of killer whales is 82 animals.

Current Population Trend

During the live-capture fishery that existed from 1967 to 1973, it is estimated that 47 killer whales, mostly immature, were taken out of this stock (Ford et al. 1994). The first complete census of this stock occurred in 1974. Between 1974 and 1993 the Southern Resident stock increased approximately 35%, from 71 to 96 individuals (Ford et al. 1994). This represents a net annual growth rate of 1.8% during those years. Since 1995, the population has declined to 82 whales (Ford et al. 2000; Center for Whale Research, unpubl. data). A Southern Resident Killer Whale Workshop, sponsored by the AFSC's National Marine Mammal Laboratory (NMML), the Center for Whale Research, Six Flags Marine World Vallejo, and The Whale Museum, was held at the NMML in Seattle, WA, on 1-2 April 2000. Workshop participants discussed possible factors influencing killer whale populations including contaminant levels (Ross et al. 2000; G. Ylitalo, pers. comm.), whale-watching activities, and the availability of prey resources (NMML 2000).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of killer whales. Studies of 'resident' killer whale pods in British Columbia and Washington waters resulted in estimated population growth rates of 2.92% and 2.54% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993). However, a population increases at the maximum growth rate (R_{MAX}) only when the population is at extremely low levels; thus, the estimate of 2.92% is not considered a reliable estimate of R_{MAX}. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (82) times one-half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a cetacean stock of unknown status, Wade and Angliss 1997), resulting in a PBR of 0.8 whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

NMFS observers have monitored the northern Washington marine set gillnet fishery since 1988 (Gearin et al. 1994, 2000; P. Gearin, unpubl. data). Observer coverage ranged from approximately 33 to 98% in the entire fishery

(coastal + inland waters) between 1994 and 1998. There was no observer coverage in this fishery in 1999, however, the total fishing effort was only 4 net days (in inland waters) and no marine mammals were reported taken. Data from 1994 to 1999 are included in Table 1, although the mean estimated annual mortality is calculated using only the most recent 5 years for which data are available. No killer whale mortalities have been recorded in this fishery since the inception of the observer program.

In 1993, as a pilot for future observer programs, NMFS in conjunction with the Washington Department of Fish and Wildlife (WDFW) monitored all non-treaty components of the Washington Puget Sound Region salmon gillnet fishery (Pierce et al. 1994). Observer coverage was 1.3% overall, ranging from 0.9% to 7.3% for the various components of the fishery. Encounters (whales within 10 m of a net) with killer whales were reported, but not quantified, though no entanglements occurred.

In 1994, NMFS and WDFW conducted an observer program during the Puget Sound non-treaty chum salmon gillnet fishery (areas 10/11 and 12/12B). A total of 230 sets were observed during 54 boat trips, representing approximately 11% observer coverage of the 500 fishing boat trips comprising the total effort in this fishery, as estimated from fish ticket landings (Erstad et al. 1996). No interactions with killer whales were observed during this fishery. The Puget Sound treaty chum salmon gillnet fishery in Hood Canal (areas 12, 12B, and 12C) and Puget Sound treaty sockeye/chum gillnet fishery in the Strait of Juan de Fuca (areas 4B, 5, and 6C) were also monitored in 1994 at 2.2% (based on % of total catch observed) and approximately 7.5% (based on % of observed trips to total landings) observer coverage, respectively (NWIFC 1995). No interactions resulting in killer whale mortalities were reported in either treaty salmon gillnet fishery.

Also in 1994, NMFS, WDFW, and the Tribes conducted an observer program to examine seabird and marine mammal interactions with the Puget Sound treaty and non-treaty sockeye salmon gillnet fishery (areas 7 and 7A). During this fishery, observers monitored 2,205 sets, representing approximately 7% of the estimated number of sets in the fishery (Pierce et al. 1996). Killer whales were observed within 10 m of the gear during 10 observed sets (32 animals in all), though none were observed to have been entangled.

An additional source of information on the number of killer whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1994 and 1999, there were no fisher self-reports of killer whale mortalities from any fisheries operating within the range of this stock. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 4 of Hill and DeMaster 1998).

Table 1. Summary of incidental mortality of killer whales (Eastern North Pacific Southern Resident stock) due to commercial and tribal fisheries and calculation of the mean annual mortality rate; n/a indicates that data are not available. Mean annual takes are based on 1995-1999 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery: coastal + inland waters)	94 95 96 97 98 99	obs data	33% 87% 59% 98% 40% 0%	0 0 0 0 0 n/a	0 0 0 0 0 n/a	0[1]
WA Puget Sound Region salmon set/drift gillnet (observer programs listed below covered segments of this fishery):	-	-	-	-	-	-
Puget Sound non-treaty salmon gillnet (all areas and species)	93	obs data	1.3%	0	0	0
Puget Sound non-treaty chum salmon gillnet (areas 10/11 and 12/12B)	94	obs data	11%	0	0	0

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Puget Sound treaty chum salmon gillnet (areas 12, 12B, and 12C)	94	obs data	2.2%	0	0	0
Puget Sound treaty chum and sockeye salmon gillnet (areas 4B, 5, and 6C)	94	obs data	7.5%	0	0	0
Puget Sound treaty and non-treaty sockeye salmon gillnet (areas 7 and 7A)	94	obs data	7%	0	0	0
Minimum total annual takes						0

[1]1994-98 mortality estimates are included in the average.

Due to a lack of observer programs, there are few data concerning the mortality of marine mammals incidental to Canadian commercial fisheries. Since 1990, there have been no reported fishery-related strandings of killer whales in Canadian waters. However, in 1994 one killer whale was reported to have contacted a salmon gillnet but did not entangle (Guenther et al. 1995). Data regarding the level of killer whale mortality related to commercial fisheries in Canadian waters are not available, though the mortality level is thought to be minimal.

During this decade there have been no reported takes from this stock incidental to commercial fishing operations (D. Ellifrit, pers. comm.), no reports of interactions between killer whales and longline operations (as occurs in Alaskan waters; see Yano and Dahlheim 1995), no reports of stranded animals with net marks, and no photographs of individual whales carrying fishing gear. The total fishery mortality and serious injury for this stock is zero.

STATUS OF STOCK

Killer whales are not listed as "depleted" under the MMPA or listed as "threatened " or "endangered" under the Endangered Species Act. Based on currently available data, the total fishery mortality and serious injury for this stock (0) is not known to exceed 10% of the calculated PBR (0.08) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury of zero animals per year is not known to exceed the PBR (0.8). Therefore, the Eastern North Pacific Southern Resident stock of killer whales is not classified as a strategic stock. The stock size has decreased in recent years, although at this time it is not possible to assess the status of this stock relative to its Optimum Sustainable Population (OSP) level.

In April 1999, Canada's Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed resident killer whales in British Columbia as "threatened," i.e., likely to become "endangered" if limiting factors are not reversed (Baird 1999). In June 2000, the Washington Department of Fish and Wildlife designated killer whales in Washington State as a "state candidate species" (a species that the Department will review for possible listing as "state endangered, threatened, or sensitive"). On 2 May 2001, NMFS received a petition from the Center for Biological Diversity and 10 co-petitioners (an 11th co-petitioner was added on 16 July 2001) to list the Eastern North Pacific Southern Resident stock of killer whales as an "endangered" or "threatened" species under the Endangered Species Act (ESA) and to designate critical habitat for this stock under that Act. On 13 August 2001 (66 FR 42499), NMFS determined that the petition presented substantial scientific information indicating that a listing may be warranted; thus, NMFS is required to conduct an ESA status review of the stock and issue a report on its findings by 2 May 2002. NMFS established a Biological Review Team for this purpose in late August 2001.

REFERENCES

Baird, R. W. 1999. Status of killer whales in Canada. Contract Report to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Ottawa. 42 pp.

Baird, R. W., and P. J. Stacey. 1988. Variation in saddle patch pigmentation in populations of killer whales (*Orcinus orca*) from British Columbia, Alaska, and Washington State. Can. J. Zool. 66 (11):2582-2585.

Baird, R. W., P. A. Abrams, and L. M. Dill. 1992. Possible indirect interactions between transient and resident killer whales: implications for the evolution of foraging specializations in the genus *Orcinus*. Oecologia 89:125-132.

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. 25 pp.

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford, and K. C. Balcomb III. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Pp. 386-406, *In:* Hammond, P. S. , S. A. Mizroch, and G. P. Donovan (eds.), Individual Recognition of Cetaceans: Use of Photo-identification and Other Techniques to Estimate Population Parameters. Rep. Int. Whal. Commn. Special Issue 12.

Black, N. A. P.O. Box 52001, Pacific Grove, CA 93950.

Braham, H. W., and M. E. Dahlheim. 1982. Killer whales in Alaska documented in the Platforms of Opportunity Program. Rep. Int. Whal. Commn. 32:643-646.

Brault, S., and H. Caswell. 1993. Pod-specific demography of killer whales (*Orcinus orca*). Ecology 74(5):1444-1454.

Center for Whale Research, 1359 Smugglers Cove Rd., Friday Harbor, WA 98250.

Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Dahlheim, M. E., D. Ellifrit, and J. Swenson. 1997. Killer Whales of Southeast Alaska: A Catalogue of Photoidentified Individuals. Day Moon Press, Seattle, WA. 82 pp. + appendices.

Ellifrit, D. Center for Whale Research, 1359 Smugglers Cove Rd., Friday Harbor, WA 98250.

Erstad, P., S. J. Jeffries, and D. J. Pierce. 1996. 1994 Report for the Puget Sound fishery observer program in management areas 10/11 & 12/12B: nontreaty chum gill net fishery. Final Report, Washington Dept. Fish and Wildlife, Olympia, WA. 14 pp.

Ford, J. K. B., and H. D. Fisher. 1982. Killer whale (*Orcinus orca*) dialects as an indicator of stocks in British Columbia. Rep. Int. Whal. Commn. 32:671-679.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 1994. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington State. University of British Columbia Press, Vancouver, BC, and University of Washington Press, Seattle. 102 pp.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 2000. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington. 2nd edition. University of British Columbia Press, Vancouver, BC, and University of Washington Press, Seattle. 104 pp.

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.

Gearin, P. J. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Gearin, P. J., S. R. Melin, R. L. DeLong, H. Kajimura, and M. A. Johnson. 1994. Harbor porpoise interactions with a chinook salmon set-net fishery in Washington State. Rep. Int. Whal. Commn. Special Issue 15:427-438.

Gearin, P. J., M. E. Gosho, J. L. Laake, L. Cooke, R. L. DeLong, and K. M. Hughes. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the state of Washington. J. Cetacean Res. Manage. 2(1):1-9.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnel, and K. C. Balcomb. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Pp. 1-100, *In:* Brueggeman, J. J. (ed.), Oregon and Washington marine mammal and seabird surveys. Final Rep. OCS Study MMS 91-0093.

Guenther, T. J., R. W. Baird, R. L. Bates, P. M. Willis, R. L. Hahn, and S. G. Wischniowski. 1995. Strandings and fishing gear entanglements of cetaceans on the west coast of Canada in 1994. Paper SC/47/O6 presented to

the International Whaling Commission, May 1995 (unpublished). 7 pp.
Hill, P. S., and D. P. DeMaster. 1998. Alaska marine mammal stock assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-97. 166 pp.
Hoelzel, A. R. 1991. Analysis of regional mitochondrial DNA variation in the killer whale; implications for cetacean conservation. Rep. Int. Whal. Commn. Special Issue 13:225-233.
Hoelzel, A. R., and G. A. Dover. 1991. Genetic differentiation between sympatric killer whale populations. Heredity 66:191-195.
Hoelzel, A. R., M. E. Dahlheim, and S. J. Stern. 1998. Low genetic variation among killer whales (*Orcinus orca*) in the Eastern North Pacific, and genetic differentiation between foraging specialists. J. Heredity 89:121-128.
Leatherwood, J. S., and M. E. Dahlheim. 1978. Worldwide distribution of pilot whales and killer whales. Naval Ocean Systems Center, Tech. Rep. 443:1-39.
Leatherwood, S., C. O. Matkin, J. D. Hall, and G. M. Ellis. 1990. Killer whales, *Orcinus orca*, photo-identified in Prince William Sound, Alaska 1976 to 1987. Can. Field Nat. 104:362-371.
Matkin, C., G. Ellis, E. Saulitis, L. Barrett-Lennard, and D. Matkin. 1999. Killer Whales of Southern Alaska. North Gulf Oceanic Society. 96 pp.
Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Bd. Can. 32:914-916.
Dahlheim, M., D. Bain, C. Sims, and D. DeMaster (compilers). 2000. Southern resident killer whale workshop, National Marine Mammal Laboratory, Seattle, WA, 1-2 April 2000. AFSC Processed Report 2000-06. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115-6349.
Northwest Indian Fisheries Commission. 1995. Monitoring of marbled murrelet and marine mammal interactions with 1994 tribal gillnet fisheries in northern Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Final Report to NMFS Contract No. 52ABNF400087. Unpubl. report. Northwest Indian Fisheries Commission. 43 pp. Available at NWIFC, 6730 Martin Way E, Olympia, WA 98516.
Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep. Int. Whal. Commn. Special Issue 12:209-242.
Pierce, D. J., W. P. Ritchie, and R. Kreuziger. 1994. Preliminary findings of seabird interactions with the non-treaty salmon gill net fishery: Puget Sound and Hood Canal Washington. Unpubl. report. Washington Dept. Fish and Wildlife, Olympia, WA. 39 pp. Available at WDFW, 600 Capitol Way N, Olympia, WA 98501.
Pierce, D. J., M. Alexandersdottir, S. J. Jeffries, P. Erstad, W. Beattie, and A. Chapman. 1996. Interactions of marbled murrelets and marine mammals with the 1994 Puget Sound sockeye gill net fishery. Final Report, Washington Dept. Fish and Wildlife, Olympia, WA. 21 pp.
Ross, P. S., G. M. Ellis, M. G. Ikonomou, L. G. Barrett-Lennard, and R. F. Addison. 2000. High PCB concentrations in free-ranging Pacific killer whales, *Orcinus orca*: effects of age, sex and dietary preference. Mar. Pollut. Bull. 40(6):504-515.
Stevens, T. A., D. Duffield, E. Asper, K. Hewlett, A. Bolz, L. Gage, and G. Bossart. 1989. Preliminary findings of restriction fragment differences in mitochondrial DNA among killer whales (*Orcinus orca*). Can. J. Zool. 67:2592-2595.
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.
Yano, K., and M. E. Dahlheim. 1995. Killer whale, *Orcinus orca*, depredation on longline catches of bottomfish in the southeastern Bering Sea and adjacent waters. Fish. Bull. 93:355-372.
Ylitalo, G. M. Environmental Conservation Division, NWFSC, NMFS, 2725 Montlake Blvd. E, Seattle, WA 98112.

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SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Short-finned pilot whales were once commonly seen off Southern California, with an apparently resident population around Santa Catalina Island, as well as seasonal migrants (Dohl et al. 1980). After a strong El Niño event in 1982-83, short-finned pilot whales virtually disappeared from this region, and despite increased survey effort along the entire U.S. west coast, few sightings were made from 1984-1992 (Jones and Szczepaniak 1992; Barlow 1997; Carretta and Forney 1993; Shane 1994; Green et al. 1992, 1993). In 1993, six groups of short-finned pilot whales were again seen off California (Carretta et al. 1995; Barlow and Gerrodette 1996), and mortality in drift gillnets increased (Julian and Beeson 1998) but sightings remain rare (Barlow 1997). Figure 1 summarizes the sighting history of short-finned pilot whales off the U.S. west coast. Although the full geographic range of the California/Oregon/Washington population is not known, it may be continuous with animals found off Baja California, and its individuals are morphologically distinct from short-finned pilot whales found farther south in the eastern tropical Pacific (Polisini 1981). Separate southern and northern forms of short-finned pilot whales have also been documented for the western North Pacific (Kasuya et al. 1988; Wada 1988; Miyazaki and Amano 1994). For the Marine Mammal Protection Act (MMPA) stock assessment reports, short-finned pilot whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Hawaiian waters.

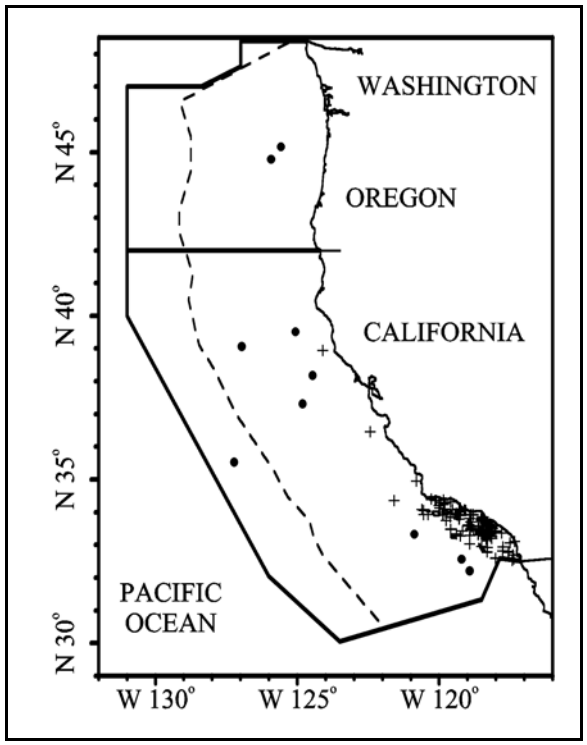

Figure 1. Short-finned pilot whale sightings made during aerial and shipboard surveys conducted off California in 1975-83 (+) and off California, Oregon and Washington, 1991-96 (●). See Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Three summer/fall shipboard surveys were conducted within 300 nmi of the coasts of California (in 1991 and 1993; Barlow and Gerrodette 1996) and California, Oregon and Washington (in 1996; Barlow 1997). The abundance of short-finned pilot whales in this region appears to be variable and may relate to oceanographic conditions, as with other odontocete species (Forney 1997, Forney and Barlow 1998). Because animals may spend time outside the U.S. Exclusive Economic Zone as oceanographic conditions change, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the above three ship surveys is 970 (CV=0.37) short-finned pilot whales (Barlow 1997).

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 717 short-finned pilot whales.

Current Population Trend

Approximately nine years after the virtual disappearance of short-finned pilot whales following the 1982-83 El Niño, they appear to have returned to California waters, as indicated by an increase in sighting records as well as incidental fishery mortality (Barlow and Gerrodette 1996; Carretta et al. 1995; Julian and Beeson 1998). However, this

cannot be considered a true growth in the population, because it merely reflects large-scale, long-term movements of this species in response to changing oceanographic conditions. It is not known where the animals went after the 82-83 El Niño, nor where the recently observed animals came from. Until the range of this population and the movements of animals in relation to environmental conditions are better documented, no inferences can be drawn regarding trends in abundance of short-finned pilot whales off California, Oregon and Washington.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for short-finned pilot whales off California, Oregon and Washington.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (717) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.40 (for a species of unknown status with a mortality rate CV>0.80; Wade and Angliss 1997), resulting in a PBR of 5.7 short-finned pilot whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of known fishery mortality and injury for this stock of short-finned pilot whale is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the relative rarity of short-finned pilot whale entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. The observed mortality of a single short-finned pilot whale in 1997 was in a pingered net. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 3.0 (CV=0.96) short-finned pilot whales taken annually.

Table 1. Summary of available information on the incidental mortality and injury of short-finned pilot whales (California/ Oregon/Washington Stock) in commercial fisheries that might take this species. All observed entanglements of pilot whales resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9 % 15.6 % 12.4 % 22.8 % 20.2 %	0 0 0 1 0	0 0 0 6 (0.96) 0	3.0 (0.96)[1]
Undetermined (probably squid purse seine fishery)	strandings	1975-90	14 short-finned pilot whales stranded in Southern California with evidence of fishery interactions, probably with the squid purse seine fishery			n/a
Minimum total annual takes						3.0 (0.96)

[1] Only 1997-98 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, Mexico 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 2700, 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, in press), 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.).

Historically, short-finned pilot whales were also killed in squid purse seine operations off Southern California (Miller et al. 1983; Heyning et al. 1994). No recent mortality has been reported, presumably because short-finned pilot whales are no longer common in the areas of squid purse seine fishing activity; however, there have been recent anecdotal reports of pilot whales seen near squid fishing operations off Southern California during the October 1997-April 98 fishing season. This fishery is not currently monitored, and has expanded markedly since 1992 (Vojkovich 1998).

STATUS OF STOCK

The status of short-finned pilot whales off California, Oregon and Washington in relation to OSP is unknown. They have declined in abundance in the Southern California Bight, likely a result of a change in their distribution since the 1982-83 El Niño, but the nature of these changes and potential habitat issues are not adequately understood. Short-finned pilot whales are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 (3.0 animals) is estimated to be less than the PBR (5.7), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for short-finned pilot whales is greater than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.

REFERENCES

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. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20pp.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-233.

Cameron, G., and K. A. Forney. 1999. Estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, 1999 (unpublished). 14pp.

Carretta, J. V. and K. A. Forney. 1993. Report of the two aerial surveys for marine mammals in California coastal waters using a NOAA DeHavilland Twin Otter aircraft, March 9-April 7, 1991, February 8-April 6, 1992. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-185. 77p.

Carretta, J. V., K. A. Forney. And J. Barlow 1995. Report of 1993-94 marine mammal surveys conducted within the U.S. Navy Outer Sea Test Range off Southern California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-217. 90p.

Dohl, T. P., K. S. Norris, R. C. Guess, J. D. Bryant, and M. W. Honig. 1980. Summary of marine mammal and seabird surveys of the Southern California Bight area, 1975-1978. Part II. Cetacea of the Southern California Bight. Final Report to the Bureau of Land Management, NTIS Rep. No. PB81248189. 414p.

Forney, K. A. 1997. Patterns of variability and environmental models of relative abundance for California cetaceans. Ph.D. Dissertation, Scripps Institution of Oceanography, University of California, San Diego.

Forney, K. A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-92. Mar. Mamm. Sci. 14:460-489.

Green, G., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington. Ch. 1. In: Oregon and Washington Marine Mammal

and Seabird Surveys. OCS Study 91-0093. Final Report prepared for Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior, Los Angeles, California.

Green, G., R. A. Grotefendt, M. A. Smultea, C. E. Bowlby, and R. A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington waters. Final Report prepared for NMFS, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, Washington, 98115, Contract #50ABNF200058.

Heyning, J. E., T. D. Lewis and C. D. Woodhouse. 1994. A note on odontocete mortality from fishing gear entanglements off Southern California. Rep. Int. Whal. Commn. Special Issue 15:439-442.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

Jones, P. A. and I. D. Szczepaniak. 1992. Report on the seabird and marine mammal censuses conducted for the long-term management strategy (LTMS), August 1990 through November 1991, for the U.S. Environmental Protection Agency, Region IX, San Francisco, July 1992.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Working Paper SC/49/SM02 presented to the International Whaling Commission, September 1997, Bournemouth, UK.

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, O., T. Miyashita, and F. Kasamatsu. 1988. Segregation of two forms of short-finned pilot whales off the Pacific coast of Japan. Sci. Rep. Whales Res. Inst. 39:77-90.

Miller, D. J., M. J. Herder and J. P Scholl. 1983. California marine mammal - fishery interaction study, 1979-1981. Administrative Report LJ-83-13C. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038. 233p.

Miyazaki, N. and M. Amano. 1994. Skull morphology of two forms of short-finned pilot whales off the Pacific coast of Japan. Rep. Int. Whaling Commn. 44:499-508.

Polisini, J. M. 1981. A comparison of *Globicephala macrorhyncha* (Gray, 1846) with the pilot whale of the North Pacific Ocean: An analysis of the skull of the broad-rostrum pilot whales of the genus *Globicephala*. Dissertation Abstracts International Vol. 41, No. 08, February 1981, p. 2928-B.

Shane, S. 1994. Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983-91. Bull. Southern California Acad. Sci. 93:13-29.

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.

Vojkovich, M. 1998. The California fishery for market squid (*Loligo opalescens*). CalCOFI Rep. 39:55-60.

Wada, S. 1988. Genetic differentiation between forms of short-finned pilot whales off the Pacific coast of Japan. Sci. Rep. Whales Res. Inst. 39:91-101.

Wade, P. R. and R. P. 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.

Revised 12/15/2000

BAIRD'S BEAKED WHALE (*Berardius bairdii*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Baird's beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific Ocean (Balcomb 1989). They have been harvested and studied in Japanese waters, but little is known about this species elsewhere (Balcomb 1989). Along the U.S. west coast, Baird's beaked whales have been seen primarily along the continental slope (Figure 1) from late spring to early fall. They have been seen less frequently and are presumed to be farther offshore during the colder water months of November through April. For the Marine Mammal Protection Act (MMPA) stock assessment reports, Baird's beaked whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Alaskan waters.

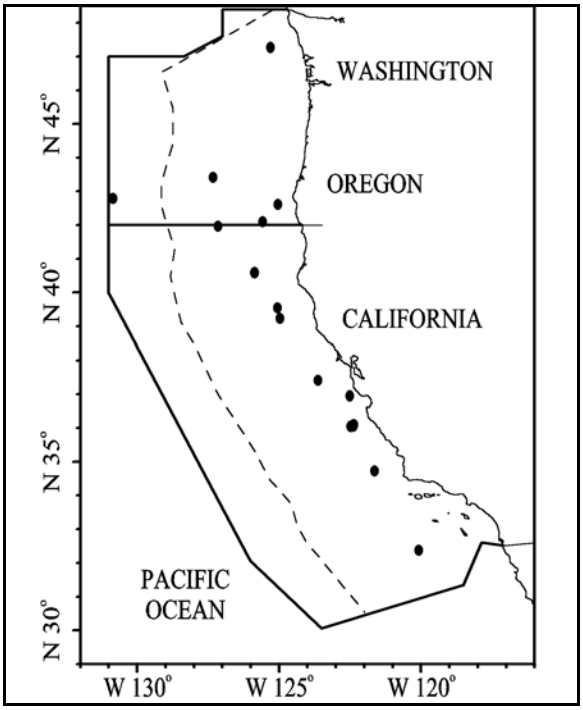

Figure 1. Baird's beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Three summer/fall shipboard surveys were conducted within 300 nmi of the coasts of California (in 1991 and 1993; Barlow and Gerrodette 1996) and California, Oregon and Washington (in 1996; Barlow 1997), resulting in a combined total of 10 Baird's beaked whale sightings. Because their distribution varies and animals probably spend time outside the U.S. Exclusive Economic Zone, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the above three ship surveys is 379 (CV=0.23) Baird's beaked whales (Barlow 1997). This abundance estimate includes correction factors for the proportion of animals missed (g(0) = 0.90 for groups of 1-3 animals, g(0)=1.0 for larger groups), which are similar to the estimate of g(0)=0.96 calculated more recently (Barlow 1999) based on dive-interval studies.

Minimum Population Estimate

The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 313 Baird's beaked whales.

Current Population Trend

Due to the rarity of sightings of this species on surveys along the U.S. West coast, no information exists regarding trends in abundance of this population. Future studies of trends must take the apparent seasonality of the distribution of Baird's beaked whales into account.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this species.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (313) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no fishery mortality; Wade and Angliss 1997), resulting in a PBR of 3.1 Baird's beaked

whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for Baird's beaked whales in this region is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the relative rarity of Baird's beaked whale entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimated annual mortality of zero Baird's beaked whales.

Table 1. Summary of available information on the incidental mortality and injury of Baird's beaked whales (California/ Oregon/Washington Stock) in commercial fisheries that might take this species. The single observed entanglement resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9% 15.6% 12.4% 23.0% 20.0%	1 0 0 0 0	6 (0.90) 0 0 0 0	0[1]
Minimum total annual takes						0

[1] Only 1997-98 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, Mexico 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 2700, 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.).

Other mortality

California coastal whaling operations killed 15 Baird's beaked whales between 1956 and 1970, and 29 additional Baird's beaked whales were taken by whalers in British Columbian waters (Rice 1974).

STATUS OF STOCK

The status of Baird's beaked whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species, but in recent years questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species, such as Baird's beaked whales (Richardson et al. 1995). They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only

for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 is zero. Because recent mortality is zero, Baird's beaked whales are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

REFERENCES

Balcomb, K. C., III. 1989. Baird's beaked whale *Berardius bairdii* Stejneger, 1883: Arnoux's beaked whale *Berardius arnuxii* Duvernoy, 1851. *In*: Ridgway, S. H. and Harrison, R. (eds.), Handbook of Marine Mammals, Vol. 4., p. 261-288. Academic Press Limited.

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. 1999. Trackline detection probability for long-diving whales. p. 209-224 *In*: G. W. Garner, S. C. Amstrup, J. L. Laake, B. F. J. Manly, L. L. McDonald, and D. G. Robertson (eds.) Marine Mammal Survey and Assessment Methods. A. A. Balkema, Rotterdam. 287 pp.

Barlow, J. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20pp.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-233.

Cameron, G., and K. A. Forney. 1999. Estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, 1999 (unpublished). 14 pp.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 1997 (unpublished). 13 pp.

Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

Rice, D. W. 1974. Whales and whale research in eastern North Pacific. p. 170-195 *In:* W. E. Schevill (ed.), The Whale Problem - A Status Report. Harvard University Press, Cambridge, MA.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thompson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 p.

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 R. P. 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.

Revised 12/15/2000

MESOPLODONT BEAKED WHALES (*Mesoplodon* spp.): California/Oregon/Washington Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

Mesoplodont beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific Ocean. At least 5 species in this genus have been recorded off the U.S. west coast, but due to the rarity of records and the difficulty in identifying these animals in the field, virtually no species-specific information is available (Mead 1989). The five species known to occur in this region are: Blainville's beaked whale (*M. densirostris*), Hector's beaked whale, (*M. hectori*), Stejneger's beaked whale (*M. stejnegeri*), Gingko-toothed beaked whale (*M. gingkodens*), and Hubbs' beaked whale (*M. carlhubbsi*). Insufficient sighting records exist off the U.S. west coast (Figure 1) to determine any possible spatial or seasonal patterns in the distribution of mesoplodont beaked whales.

Until methods of distinguishing these five species are developed, the management unit must be defined to include all *Mesoplodon* stocks in this region. However, in the future, species-level management is desirable, and a high priority should be placed on finding means to obtain species-specific abundance information. For the Marine Mammal Protection Act (MMPA) stock assessment reports, three *Mesoplodon* stocks are defined: 1) all *Mesoplodon* species off California, Oregon and Washington (this report), 2) *M. stejnegeri* in Alaskan waters, and 3) *M. densirostris* in Hawaiian waters.

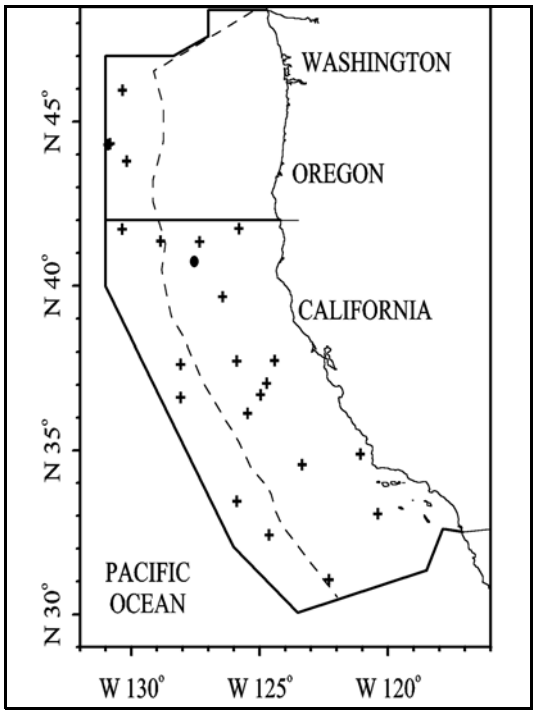

Figure 1. *Mesoplodon* beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Key: ● = *Mesoplodon densirostris,* + = *Mesoplodon* spp. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Although mesoplodont beaked whales have been sighted along the U.S. west coast on several line transect surveys utilizing both aerial and shipboard platforms, sightings have generally been too rare to produce reliable population estimates, and species identification has been problematic. Previous abundance estimates have been imprecise and biased downward by an unknown amount because of the large proportion of time mesoplodont beaked whales spend submerged, and because the surveys on which they were based covered only California waters, and thus could not include animals off Oregon/Washington. Furthermore, there were a large number of unidentified beaked whale sightings, which were either *Mesoplodon* sp. or Cuvier's beaked whales (*Ziphius cavirostris*). Recent analyses (Barlow and Gerrodette 1996, Barlow and Sexton 1996, Barlow 1997) have resulted in improved estimates of abundance by 1) combining data from three surveys conducted within 300 nmi of the coasts of California (in 1991 and 1993; Barlow and Gerrodette 1996) and California, Oregon and Washington (in 1996; Barlow 1997), 2) whenever possible, assigning unidentified beaked whale sightings to *Mesoplodon* spp. or *Ziphius cavirostris* based on written descriptions, size estimates, and 'most probable identifications' made by the observers at the time of the sightings, and 3) estimating a correction factor for animals missed because they are submerged, based on dive-interval data collected for mesoplodont whales in 1993-95 (about 26% of all trackline groups are estimated to be seen). The first species-specific abundance estimate is now available for Blainville's beaked whale, which was identified once during the 1993 cruise. Because their distribution varies and animals probably spend time outside the U.S. Exclusive Economic Zone, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimates for California, Oregon and Washington waters based on the above analyses are 3,738 (CV=0.50) mesoplodont beaked whales of unknown species plus 360 (CV=2.0) Blainville's beaked whales (Barlow 1997, with corrected CV).

Minimum Population Estimate

Based on the combined abundance estimate of 4,098 (CV=0.50), the minimum population estimate (defined as the log-normal 20th percentile of the abundance estimate) for mesoplodont beaked whales in California, Oregon, and Washington is 2,734 animals. This includes a species-specific minimum abundance estimate of 123 Blainville's beaked whales.

Current Population Trend

Due to the rarity of sightings of these species on surveys along the U.S. West coast, no information exists regarding possible trends in abundance.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for mesoplodont beaked whales.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (2,734) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known recent fishery mortality; Wade and Angliss 1997), resulting in a PBR of 27 mesoplodont beaked whales per year. This includes at least 1.1 Blainville's beaked whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for mesoplodont beaked whales in this region is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1). Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). A recently completed genetic analysis of tissue samples has allowed the reliable identification of the majority of these animals (Henshaw et al. 1997). Based on past patterns of identification (NMFS, unpublished data), the remaining unidentified beaked whale is likely to have been a *Mesoplodon* sp. 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, because of interannual variability in entanglement rates and the relative rarity of mesoplodont beaked whale entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this group of species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimated annual mortality of zero mesoplodont beaked whales.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, and may take animals from the same populations. 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 2700, 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.).

STATUS OF STOCKS

The status of mesoplodont beaked whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species, but in recent years questions have been raised regarding potential effects of human-made sounds on

Table 1. Summary of available information on the incidental mortality and injury of *Mesoplodon* beaked whales (California/Oregon/Washington Stocks) in commercial fisheries that might take these species. All observed entanglements of *Mesoplodon* beaked whales resulted in the death of the animal. Coefficients of variation for mortality

estimates are provided in parentheses. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	Hubbs' beaked whale, *Mesoplodon carlhubbsi*					
	observer data	1994	17.9%	2	11 (0.64)	
		1995	15.6%	0	0	
		1996	12.4%	0	0	0[1]
		1997	23.0%	0	0	
		1998	20.0%	0	0	
	Stejneger's beaked whale, *Mesoplodon stejnegeri*					
	observer data	1994	17.9%	1	6 (0.91)	
		1995	15.6%	0	0	
		1996	12.4%	0	0	0[1]
		1997	23.0%	0	0	
		1998	20.0%	0	0	
	Unidentified beaked whale (probably *Mesoplodon*)					
	observer data	1994	17.9%	1	6 (0.90)	
		1995	15.6%	0	0	
		1996	12.4%	0	0	0[1]
		1997	23.0%	0	0	
		1998	20.0%	0	0	
Minimum total annual takes of *Mesoplodon* beaked whales						0

[1] Only 1997-98 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).

deep-diving cetacean species, such as mesoplodont beaked whales (Richardson et al. 1995). In particular, Low Frequency Active Sonar (LFAS) has been implicated in the mass stranding of beaked whales in the Mediterranean Sea (Frantzis 1998) and more recently in the Caribbean. None of the five species is listed as "threatened" or "endangered" under the Endangered Species Act nor considered "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 is zero. Because recent mortality is zero, mesoplodont beaked whales are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero. It is likely that the difficulty in identifying these animals in the field will remain a critical obstacle to obtaining species-specific abundance estimates and stock assessments in the future.

REFERENCES

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. Southwest Fisheries Science Center Administrative Report. LJ-97-11. 25pp.

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. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20pp.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-233.

Barlow, J. and S. Sexton. 1996. The effect of diving and searching behavior on the probability of detecting track-line groups, g_0, of long-diving whales during line transect surveys. Administrative Report LJ-96-14. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038, USA. 21 p.

Cameron, G., and K. A. Forney. 1999. Estimates of cetacean mortality in the California gillnet fisheries for 1997 and

1998. Paper SC/51/O4 presented to the International Whaling Commission, 1999 (unpublished). 14pp.
Frantzis, A. 1998. Does acoustic testing strand whales? Nature 392(5):29.
Henshaw, M. D., R. G. LeDuc, S. J. Chivers, and A. E. Dizon. 1997. Identifying beaked whales (family Ziphiidae) using mtDNA sequences. Marine Mammal Science 13:487-495.
Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.
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 p.
Julian, F. 1997. Cetacean mortality in California gill net fisheries: preliminary estimates for 1996. Int. Whal. Commn. Working Paper SC/49/SM2. 13pp.
Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fishery Bulletin 96:271-284.
Mead, J. G. 1989. Beaked whales of the genus *Mesoplodon*. *In*: Ridgway, S. H. and Harrison, R. (eds.), Handbook of Marine Mammals, Vol. 4., p. 349-430. Academic Press Limited.
National Marine Fisheries Service, Southwest Fisheries Science Center. Unpublished data.
Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thompson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 p.
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 R. P. 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.

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CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Cuvier's beaked whales are distributed widely throughout deep waters of all oceans (Heyning 1989). Off the U.S. west coast, this species is the most commonly encountered beaked whale (Figure 1). No seasonal changes in distribution are apparent from stranding records, and morphological evidence is consistent with the existence of a single eastern North Pacific population from Alaska to Baja California, Mexico (Mitchell 1968). However, there are currently no international agreements for cooperative management of this species. For the Marine Mammal Protection Act (MMPA) stock assessment reports, Cuvier's beaked whales within the Pacific U.S. Exclusive Economic Zone are divided into three discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), 2) Alaskan waters, and 3) Hawaiian waters.

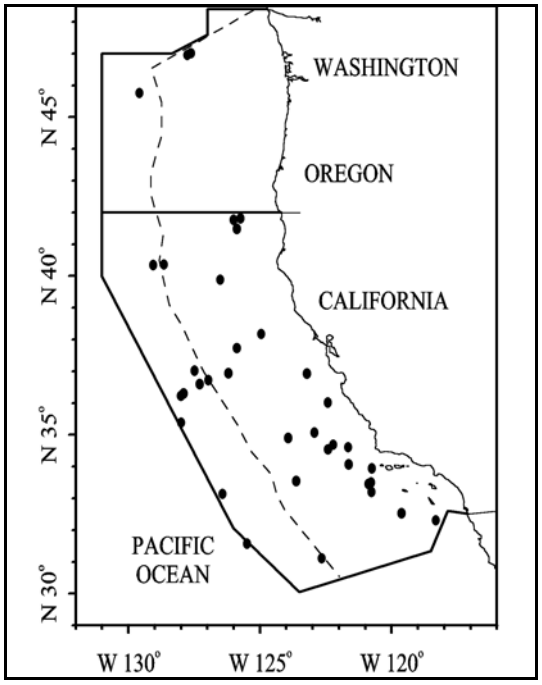

Figure 1. Cuvier's beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Although Cuvier's beaked whales have been sighted along the U.S. west coast on several line transect surveys utilizing both aerial and shipboard platforms, sightings have generally been too rare to produce reliable population estimates. Previous abundance estimates have been imprecise and biased downward by an unknown amount because of the large proportion of time this species spends submerged, and because the ship surveys on which they were based covered only California waters, and thus could not observe animals off Oregon/Washington. Furthermore, there were a large number of unidentified beaked whale sightings, which were probably either *Mesoplodon* sp. or Cuvier's beaked whales (*Ziphius cavirostris*). Recent analyses (Barlow and Gerrodette 1996, Barlow and Sexton 1996) have resulted in improved estimates of abundance by 1) combining data from three surveys conducted within 300 nmi of the coasts of California (in 1991 and 1993; Barlow and Gerrodette 1996) and California, Oregon and Washington (in 1996; Barlow 1997), 2) whenever possible, assigning unidentified beaked whale sightings to *Mesoplodon* spp. or *Ziphius cavirostris* based on written descriptions, size estimates, and 'most probable identifications' made by the observers at the time of the sightings, and 3) estimating a correction factor for animals missed because they are submerged, based on dive-interval data collected for Cuvier's beaked whales in 1993-95 (an estimated 13% of all groups are estimated to be seen). Because animals probably spend time outside the U.S. Exclusive Economic Zone, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the above analyses is 5,870 (CV=0.38) Cuvier's beaked whales (Barlow 1997, with corrected CV).

Minimum Population Estimate

Based on the above abundance estimate and CV, the minimum population estimate (defined as the log-normal 20th percentile of the abundance estimate) for Cuvier's beaked whales in California, Oregon, and Washington is 4,309 animals.

Current Population Trend

Due to the rarity of sightings of this species on surveys along the U.S. West coast, no information exists regarding trends in abundance of this population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this species.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (4,309) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known recent fishery mortality; Wade and Angliss 1997), resulting in a PBR of 43 Cuvier's beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for Cuvier's beaked whales in this region is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the relative rarity of Cuvier's beaked whale entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimated annual mortality of zero Cuvier's beaked whales.

Table 1. Summary of available information on the incidental mortality and injury of Cuvier's beaked whales (California/ Oregon/Washington Stock) in commercial fisheries that might take this species. One Cuvier's beaked whale was released alive in the driftnet fishery in 1995; all other entanglements resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses. Annual mortality estimates for 1995 are shown both including and excluding the animal released alive. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality + ReleasedAlive	Estimated Annual Mortality / Mortality + Entanglements	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9% 15.6% 12.4% 23.0% 20.0%	6 5+1 0 0 0	34 (0.36) 32 (0.40) / 39 (0.36) 0 0 0	0[1]
Minimum total annual takes						0

[1] Only 1997-98 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, Mexico 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 2700, 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.).

STATUS OF STOCK

The status of Cuvier's beaked whales in California, Oregon and Washington waters relative to OSP is not

known, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species, but in recent years questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species, such as Cuvier's beaked whales (Richardson et al. 1995). In particular, Low Frequency Active Sonar (LFAS) has been implicated in the mass stranding of beaked whales in the Mediterranean Sea (Frantzis 1998) and more recently in the Caribbean. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 is zero. Because recent mortality is zero, Cuvier's beaked whales are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

REFERENCES

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. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20pp.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-233.

Barlow, J. and S. Sexton. 1996. The effect of diving and searching behavior on the probability of detecting track-line groups, g_0, of long-diving whales during line transect surveys. Administrative Report LJ-96-14. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038, USA. 21 p.

Cameron, G., and K. A. Forney. 1999. Estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, 1999 (unpublished). 14pp.

Frantzis, A. 1998. Does acoustic testing strand whales? Nature 392(5):29.

Heyning, J. E. 1989. Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823. pp. 289-308 *In:* Ridgway, S. H. and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 4. Academic Press.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 1997 (unpublished). 13 pp.

Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

Mitchell, E. 1968. Northeast Pacific stranding distribution and seasonality of Cuvier's beaked whale, *Ziphius cavirostris*. Can. J. Zool. 46:265-279.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thompson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 p.

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 R. P. 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.

Revised 12/15/2000

PYGMY SPERM WHALE (*Kogia breviceps*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Pygmy sperm whales are distributed throughout deep waters and along the continental slopes of the North Pacific and other ocean basins (Ross 1984; Caldwell and Caldwell 1989). Along the U.S. west coast, sightings of this species and of animals identified only as *Kogia* sp. have been very rare (Figure 1). However, this is probably a reflection of their pelagic distribution, small body size and cryptic behavior, rather than an indication of true rareness. Strandings of pygmy sperm whales in this region are known from California, Oregon and Washington (Roest 1970; Caldwell and Caldwell 1989; NMFS, Northwest Region, unpublished data; NMFS, Southwest Region, unpublished data). Available data are insufficient to identify any seasonality in the distribution of pygmy sperm whales, or to delineate possible stock boundaries. For the Marine Mammal Protection Act (MMPA) stock assessment reports, pygmy sperm whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Hawaiian waters.

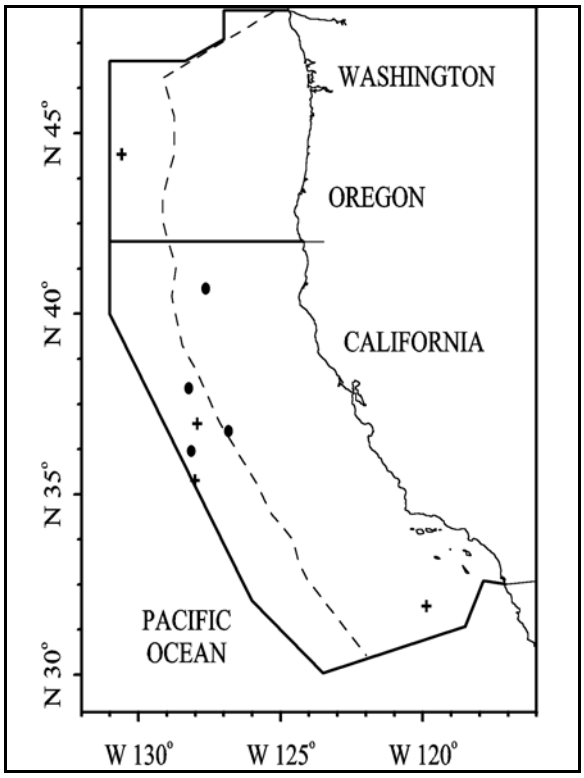

Figure 1. *Kogia* sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Key: ● = *Kogia breviceps,* + = *Kogia* spp. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Although pygmy sperm whales have been sighted along the U.S. west coast on several line transect surveys utilizing both aerial and shipboard platforms, sightings have generally been too rare to produce reliable population estimates. Previous abundance estimates have been imprecise and biased downward by an unknown amount because pygmy sperm whales spend a large proportion of time submerged and are very difficult to detect at the surface unless seas are calm. Furthermore, the ship survey covered only California waters, and thus could not observe animals off Oregon/Washington. Recent analyses (Barlow and Gerrodette 1996, Barlow and Sexton 1996) have resulted in improved estimates of abundance by 1) combining data from three surveys conducted within 300 nmi of the coasts of California (in 1991 and 1993; Barlow and Gerrodette 1996) and California, Oregon and Washington (in 1996; Barlow 1997), and 2) estimating a correction factor for animals missed because they are submerged, based on dive-interval data collected for *Kogia simus* in 1993-95 (about 19% of all groups are estimated to be seen). Because animals probably spend time outside the U.S. Exclusive Economic Zone, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The 1991-96 weighted average abundance estimate for California, Oregon and Washington waters based on the above analyses is 2,933 (CV=0.54) pygmy sperm whales plus an estimated 1,813 (CV=1.53) pygmy or dwarf sperm whales, based on sightings that could only be identified to the genus *Kogia* (Barlow 1997, with corrected CV). Because there have been no reported sightings, strandings, or entanglements of dwarf sperm whales along the U.S. West coast since the early 1970s, it is almost certain that these additional *Kogia* were pygmy sperm whales, bringing the total abundance estimate to 4,746 (CV=0.67).

Minimum Population Estimate

Based on the above abundance estimate and CV, the minimum population estimate (defined as the log-normal 20th percentile of the total *Kogia* abundance estimate) for pygmy sperm whales in California, Oregon, and Washington is 2,837 animals.

Current Population Trend

Due to the rarity of sightings of this species on surveys along the U.S. West coast, no information exists regarding trends in abundance of this population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this species.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (2,837) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known recent fishery mortality; Wade and Angliss 1997), resulting in a PBR of 28 pygmy sperm whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for pygmy sperm whales and unidentified *Kogia*, which may have been pygmy sperm whales, is shown in Table 1. More detailed information on the drift gillnet fishery is provided in Appendix 1. In the California drift gillnet fishery, no mortality of pygmy sperm whales or unidentified *Kogia* was observed during the most recent five years of monitoring, 1994-98 (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999). 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, because of interannual variability in entanglement rates and the rarity of *Kogia* entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of pygmy sperm whales. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimated annual mortality of zero pygmy sperm whales.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico 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 2700, 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.).

STATUS OF STOCK

The status of pygmy sperm whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species, but in recent years questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species, such as pygmy sperm whales (Richardson et al. 1995). They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including driftnet mortality only for years after implementation of the Take Reduction Plan (1997-98), the average annual human-caused mortality in 1994-98 is zero. Because recent mortality is zero, pygmy sperm whales are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

Table 1. Summary of available information on the incidental mortality and injury of pygmy sperm whales and unidentified *Kogia* sp. (California/Oregon/Washington Stock) in commercial fisheries that might take this species. Coefficients of variation for mortality estimates are provided in parentheses. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality *K. breviceps /Kogia* sp.	Estimated Annual Mortality of *K. breviceps/Kogia* sp.	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	1994 1995 1996 1997 1998	17.9% 15.6% 12.4% 23.0% 20.0%	0 / 0 0 / 0 0 / 0 0 / 0 0 / 0	0 / 0 0 / 0 0 / 0 0 / 0 0 / 0	0[1]
Minimum total annual takes						0

[1] Only 1997-98 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).

REFERENCES

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. and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20pp.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-233.

Barlow, J. and S. Sexton. 1996. The effect of diving and searching behavior on the probability of detecting track-line groups, g_0, of long-diving whales during line transect surveys. Administrative Report LJ-96-14. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038, USA. 21 p.

Caldwell, D. K. and M. C. Caldwell. 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838): Dwarf sperm whale *Kogia simus* Owen, 1866. pp. 235-260 *In:* Ridgway, S. H. and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 4. Academic Press.

Cameron, G., and K. A. Forney. 1999. Estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, 1999 (unpublished). 14 pp.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 1997 (unpublished). 13 pp.

Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

NMFS, Southwest Region, 501 West Ocean Blvd, Long Beach, CA 90802-4213.

Oregon Department of Fish and Game, Unpublished data.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thompson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 p.

Roest, A. I. 1970. *Kogia simus* and other cetaceans from San Luis Obispo County, California. J. Mammal. 51:410-417.

Ross, G. J. B. 1984. The smaller cetaceans of the south east coast of southern Africa. Ann. Cape Prov. Mus. Nat. Hist. 15:173-410.

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.

Revised 12/31/2001

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 40ºN 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 150ºW at the equator, is 160ºW between 40-50ºN, and ends up at 180ºW north of 50ºN; 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 150ºW) 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 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).

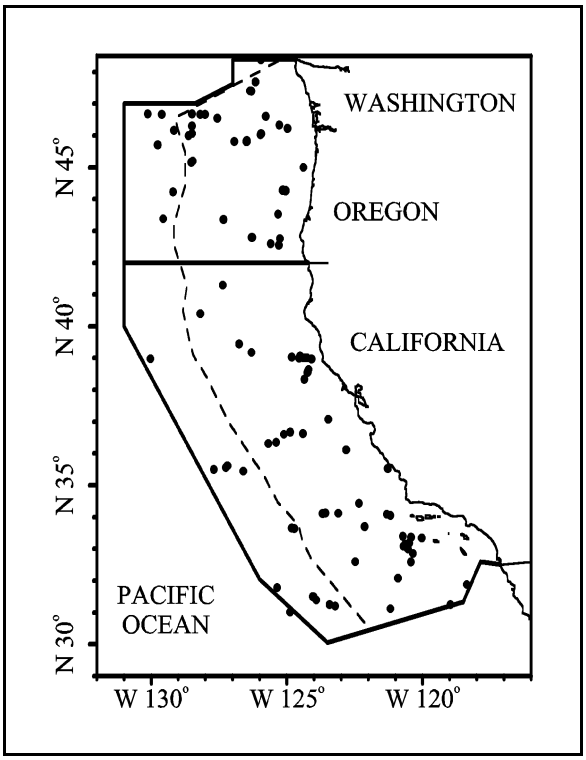

Figure 1. Sperm whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1989-96. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. Greater effort was conducted off California (south of 42°N) and in the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

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) 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), 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)

[1] 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 Physeter macrocephalus, Linnaeus 1758. pp. 177-233 In: S. H. Ridgway and R. J. Harrison (eds.). Handbook of Marine Mammals, Vol. 4. 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.

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HUMPBACK WHALE (*Megaptera novaeangliae*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Although the International Whaling Commission (IWC) only considered one stock (Donovan 1991), there is now good evidence for multiple populations of humpback whales in the North Pacific (Johnson and Wolman 1984; Baker et al. 1990). Aerial, vessel, and photo-identification surveys, and genetic analyses indicate that within the U.S. EEZ, there are at least three relatively separate populations that migrate between their respective summer/fall feeding areas and winter/spring calving and mating areas (Calambokidis et al. 2001, Baker et al. 1998): 1) winter/spring populations in coastal Central America and Mexico which migrate to the coast of California to southern British Columbia in summer/fall (Steiger et al. 1991, Calambokidis et al. 1993) - referred to as the eastern North Pacific stock (Figure 1); 2) winter/spring populations of the Hawaiian Islands which migrate to northern British Columbia/Southeast Alaska and Prince William Sound west to Kodiak (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 2001) - referred to as the central North Pacific stock; and 3) winter/spring populations of Japan which, based on Discovery Tag information, probably migrate to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) in summer/fall (Berzin and Rovnin 1966, Nishiwaki 1966, Darling 1991) - referred to as the western North Pacific stock. Winter/spring populations of humpback whales also occur in Mexico's offshore islands; the migratory destination of these whales is not well known (Calambokidis et al. 1993, Calambokidis et al. 2001), but Norris et al. (1999) speculate that they may travel to the Bering Sea or Aleutian Islands. This stock structure represents the predominant migration patterns, but there is not a perfect correspondence between the breeding and feeding areas that are paired above. For example, some individuals migrate from Mexico to the Gulf of Alaska and others migrate from Japan to British Columbia. In general, interchange occurs (at low levels) between breeding areas, but fidelity is extremely high among the feeding areas (Calambokidis et al. 2001).

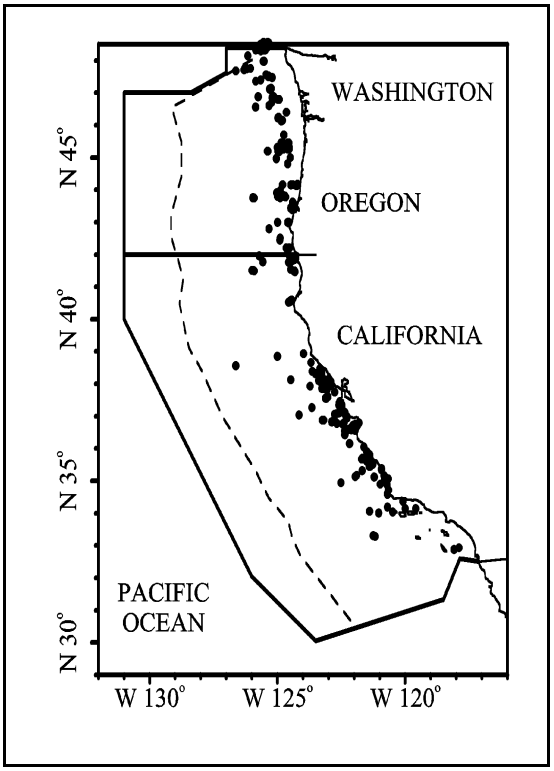

Figure 2. Humpback whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1989-96. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. Greater effort was conducted off California (south of 42°N) and in the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

Significant levels of genetic differences were found between the California and Alaska feeding groups based on analyses of mitochondrial DNA (Baker et al. 1990) and nuclear DNA (Baker et al. 1993). The genetic exchange rate between California and Alaska is estimated to be less than 1 female per generation (Baker 1992). Two breeding areas (Hawaii and coastal Mexico) showed fewer genetic differences than did the two feeding areas (Baker 1992). This is substantiated by the observed movement of individually-identified whales between Hawaii and Mexico (Baker et al. 1990). There have been no individual matches between 597 humpbacks photographed in California and 617 humpbacks photographed in Alaska (Calambokidis et al. 1996). Only two of the 81 whales photographed in British Columbia have matched with a California catalog (Calambokidis et al. 1996), indicating that the U.S./Canada border is an approximate geographic boundary between feeding populations.

Until further information becomes available, three management units of humpback whales (as described above) are recognized within the U.S. EEZ of the North Pacific: the eastern North Pacific stock (this report), the central North

Pacific stock, and the western North Pacific stock. The central and western North Pacific stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Based on whaling statistics, the pre-1905 population of humpback whales in the North Pacific was estimated to be 15,000 (Rice 1978), but this population was reduced by whaling to approximately 1,200 by 1966 (Johnson and Wolman 1984). The North Pacific total now almost certainly exceeds 6,000 humpback whales (Calambokidis et al. 1997). Estimates of the abundance of the eastern Pacific stock of humpback whales were made by aerial survey (Dohl 1983; Forney et al. 1995) and ship surveys (Barlow 1995), but those estimates are now over 9 years old and the aerial estimates did not include correction factors for diving whales that would be missed. More recent estimates are available from ship surveys and mark-recapture studies. Barlow and Taylor (2001) estimate 1,177 (CV = 0.28) humpbacks in California, Oregon, and Washington waters based on their summer/fall ship line-transect surveys in 1993 and 1996. Calambokidis et al. (2001) estimate humpback whale abundance in these feeding areas from 1991 to 2000 using Petersen mark-recapture estimates based on photo-identification collections in adjacent pairs of years (Figure 2). These data show a general upward trend in abundance followed by a large (but not statistically significant) drop in the 1999/2000 estimate. The authors attributed this decline to non-random sampling and bias towards sampling in Monterey Bay in both 1999 and 2000 (Calambokidis et al. 2001). Sampling in 1998 was not so geographically biased, and the authors argue that the Petersen estimate based on comparing 1998 to 2000 (856 humpback whales, CV = 0.12) is less biased than the 1999/2000 estimate. In general, mark-recapture estimates are negatively biased due to heterogeneity in sighting probabilities (Hammond 1986); however, this bias is likely to be minimal because the above mark-recapture estimate is based on data from over half of the entire population (the 1998/2000 data contained 516 known individuals). The photographic mark-recapture estimates from Mexico (Urban et al. 1999) include whales from several feeding destinations and probably two different stocks. The ship line transect estimate (Barlow and Taylor 2001) is less precise than the mark-recapture estimates and is negatively biased because it does not include some humpback whales which could not be identified in the field and which were recorded as "unidentified large whale".

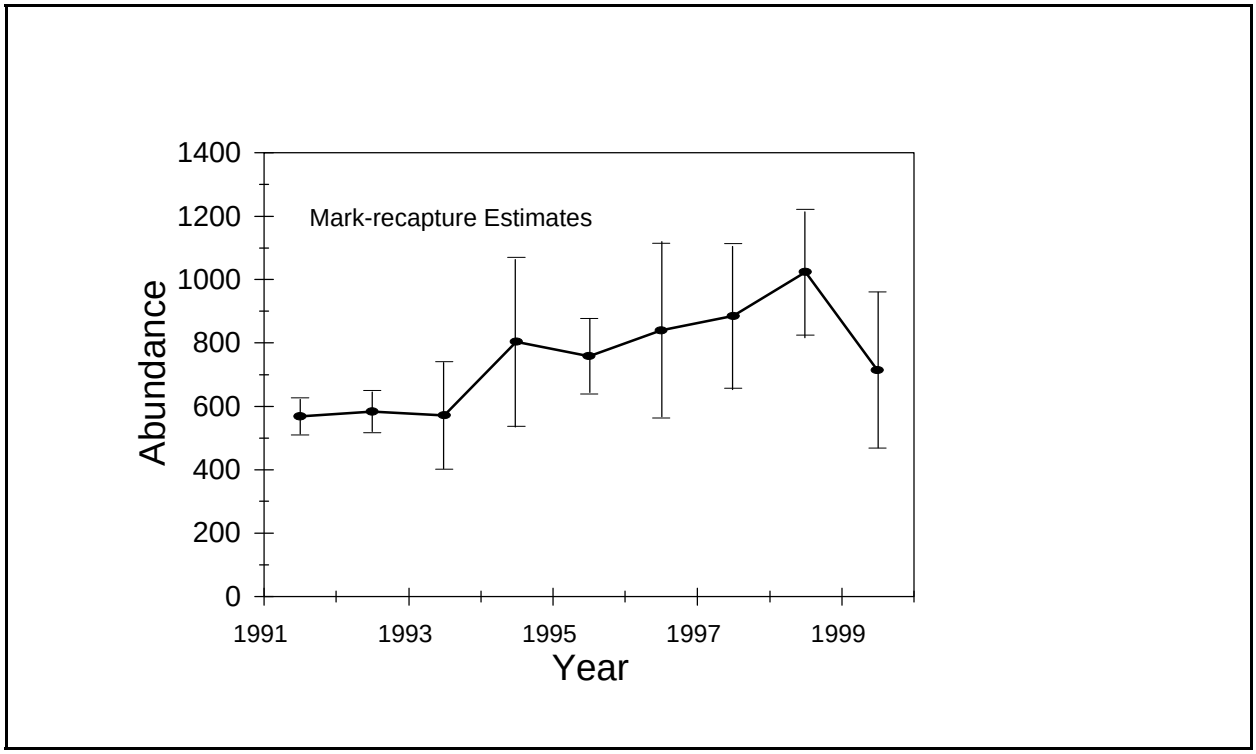

Figure 3. Mark-recapture estimates of the abundance of humpback whales feeding off California, Oregon, and Washington based on photo-identification studies (Calambokidis et al. 2001).

Minimum Population Estimate

The minimum population estimate for humpback whales in the California/Mexico stock is taken as the lower 20th percentile of the log-normal distribution of 1998/2000 abundance estimated from mark-recapture methods (Calambokidis et al. 2001) or approximately 774.

Current Population Trend

Ship surveys provide some indication that humpback whales increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1994) and between 1991 and 1996 (Barlow 1997). Mark-recapture population estimates increased steadily from 1988/90 to 1997-98 at about 8% per year (Calambokidis et al. 1999) and the estimate for 1998-99 is again higher than previous estimates (Calambokidis et al. 2000). The 1999-2000 estimate was less than previous estimates, but questions about geographic sampling bias confound the interpretation of data from those years (Calambokidis et al. 2001). Population estimates for the entire North Pacific have also increased substantially from 1,200 in 1966 to 6,000-8,000 circa 1992. Although these estimates are based on different methods and the earlier estimate is extremely uncertain, the growth rate implied by these estimates (6-7%) is consistent with the recently observed growth rate of the eastern North Pacific stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The proportion of calves in the California/Mexico stock from 1986 to 1994 appeared much lower than previously measured for humpback whales in other areas (Calambokidis and Steiger 1994), but in 1995-97 a greater proportion of calves were identified, and the 1997 reproductive rates for this population are closer to those reported for humpback whale populations in other regions (Calambokidis et al. 1998). Despite the apparently low proportion of calves, two independent lines of evidence indicate that this stock appears to be growing (Barlow 1994; Calambokidis et al. 2000) with a best estimate of 8% growth per year (Calambokidis et al. 1999).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (774) times one half the estimated population growth rate for this stock of humpback whales (½ of 8%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of 3.1. Because this stock spends approximately half its time outside the U.S. EEZ, the PBR allocation for U.S. waters is 1.6 whales per year.

HUMAN-CAUSED MORTALITY

Historic Whaling

The reported take of North Pacific humpback whales by commercial whalers totaled approximately 7,700 between 1947 and 1987 (C. Allison, IWC unpubl. data). In addition, approximately 7,300 were taken along the west coast of North America from 1919 to 1929 (Tonnessen and Johnsen 1982). Total 1910-1965 catches from the California-Washington stock includes at least the 2,000 taken in Oregon and Washington, the 3,400 taken in California, and the 2,800 taken in Baja California (Rice 1978). Shore-based whaling apparently depleted the humpback whale stock off California twice: once prior to 1925 (Clapham et al. 1997) and again between 1956 and 1965 (Rice 1974). There has been a prohibition on taking humpback whales since 1966.

Fishery Information

A 1996-2000 summary of known fishery mortality and injury for this stock of humpback whales is given in Table 1. Detailed information on these fisheries is provided in Appendix 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). 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- 2000 data. This results in an average estimate of zero humpback whales taken annually. Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net. The deaths of two humpback whales that stranded in the Southern California Bight have been attributed to entanglement in fishing gear (Heyning and Lewis 1990), and a humpback whale was observed off Ventura, CA in 1993 with a 20 ft section of netting wrapped around and trailing behind. During the period 1996-2000, a humpback cow-calf pair was seen entangled in a net off Big Sur, California (1999) and another lone humpback was seen entangled in line

and fishing buoys off Grover City (2000), but the fate of these animals is not known (J. Cordero, NMFS unpubl. data). One humpback whale was entangled and released alive in the swordfish/thresher shark drift gillnet fishery in November of 1999 at N33°17' W120° 49' (set DN-SD-0949). Other unobserved fisheries may also result in injuries or deaths of humpback whales. In 1997, one humpback whale was snagged by a central California salmon troller, and the animal swam away with the hook and many feet of trailing monofilament (NMFS, Southwest Region, unpublished data); this type of injury is not likely to be serious.

Table 1. Summary of available information on the incidental mortality and injury of humpback whales (eastern North Pacific stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998, Cameron and Forney 1999, 2000; Carretta 2001). Injury includes any entanglement that does not result in immediate death and may include serious injury resulting in death. n/a indicates that data are not available. Mean annual takes are based on 1996-2000 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality (and Injury)	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1996 1997 1998 1999 2000	observer data	12.4% 23.0% 20.0% 20.0% 25.1%	0 0 0 0 0	Mortality 0,0,0,0,0 Injury 0,0,0,0,0	Mortality 0 Injury 0[1]
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	1990-94 1999 2000	observer data	10-15% 23.1%[3] 26.9%[3]	0,0,0,0,0 0[3] 0[3]	0,0,0,0,0 0[2] 0[2]	0[2]
Unidentified fisheries	1996-2000	stranding & sightings	n/a	0 (3)	n/a	≥ 0.6
CA salmon troll fishery	1997	incidental report	0%	(1)	n/a	Injury ≥ 0.2 (n/a)
Total annual takes						≥ 0.8

[1] Only 1997-2000 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).
[2] The CA set gillnets were not observed in 1995-98, and observations in 1999-2000 only included Monterey Bay; mortality for unobserved areas and times was extrapolated from effort estimates and 1991-94 entanglement rates.
[3] Observer coverage and observed mortality in 1999-2000 only includes the portion of the fishery in Monterey Bay.

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

Ship strikes were implicated in the deaths of at least two humpback whales in 1993, one in 1995, and one in 2000 (J. Cordaro, NMFS unpubl. data). Unidentified whales, which may have been a humpback whales, were struck and injured by boats in Feb. 1997 and in May 1999 (J. Cordaro, NMFS unpubl. data). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not have obvious signs of trauma. Several humpback whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (J. Calambokidis, pers. comm.). The average number of humpback whale deaths by ship

strikes for 1996-2000 is at least 0.2 per year.

Other human-caused mortality

A humpback whale died and stranded near Moss Landing in 2000 with synthetic (possibly nylon) line wrapped around its flukes. The origin of this line (fishery or other anthropogenic source) is unknown. The average number of humpback deaths from unknown anthropogenic sources is 0.2 per year from 1996-2000.

STATUS OF STOCK

Humpback whales in the North Pacific were estimated to have been reduced to 13% of carrying capacity (K) by commercial whaling (Braham 1991). Clearly the North Pacific population was severely depleted. The initial abundance has never been estimated separately for the eastern North Pacific stock, but this stock was also depleted (probably twice) by whaling (Rice 1974; Clapham et al. 1997). Humpback whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the California/Mexico stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The estimated annual mortality and injury due to entanglement (0.8/yr), other anthropogenic sources (0.2/yr), plus ship strikes (0.2/yr) in California is less than the PBR allocation of 1.6 for U.S. waters. In a review of the severity of injury to the humpback whale entangled in 1997, the Pacific Scientific Review Group determined that this animal was not seriously injured. The three humpbacks that were observed to be entangled at sea may have been seriously injured. Based on strandings and gillnet observations, annual humpback whale mortality and serious injury in California's drift gillnet fishery is probably greater than 10% of the PBR; therefore, total fishery mortality may not be approaching zero mortality and serious injury rate. The eastern North Pacific stock appears to be increasing in abundance. The increasing levels of anthropogenic noise in the world's oceans, such as those produced by ATOC (Acoustic Thermometry of Ocean Climate) or LFA (Low Frequency Active) Sonar, have been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound.

REFERENCES

Allison, C. International Whaling Commission. The Red House, 135 Station Road, Impington, Cambridge, UK CB4 9NP.

Baker, C. S. 1992. Genetic variability and stock identity of humpback whales, world-wide. Final Contract Report to Int. Whal. Commn. 45pp.

Baker, C. S., D. A. Gilbert, M. T. Weinrich, R. Lambertsen, J. Calambokidis, B. McArdle, G. K. Chambers, and S. J. O'Brien. 1993. Population characteristics of DNA fingerprints in humpback whales (Megaptera novaeangliae). J. Heredity 84:281-290.

Baker, C. S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J. M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Mol. Ecol. 7:695-708.

Baker, C. S., S. R. Palumbi, R. H. Lambertsen, M. T. Weinrich, J. Calambokidis, and S. J. O'Brien. 1990. Influence of seasonal migration on geographic distribution of mitochondrial DNA haplotypes in humpback whales. Nature 344(15):238-240.

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. 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. 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.

Berzin, A. A., and A. A. Rovnin. 1966. The distribution and migrations of whales in the northeastern part of the Pacific, Chukchi and Bering Seas. Izvestiya Tikhookeanskogo Nauchno-Issledovatel'skogo Institut Rybnogo Khozyaistva I Okeanografii 58:179-207. (Translated by Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Seattle, 1968, pp. 103-136 *In:* K. I. Panin (ed.), Soviet Research on Marine Mammals of the Far East).

Braham, H. W. 1991. Endangered whales: status update. A Report on the 5-year status of stocks review under the 1978 amendments to the U.S. Endangered Species Act. NMFS Unpublished Report.

Calambokidis, J., T. Chandler, K. Rasmussen, G. H. Steiger, L. Schlender. 1998. Humpback and blue whale photographic identification: Report on research in 1997. Contract Report to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 41pp.

Calambokidis, J., T. Chandler, K. Rasmussen, G. H. Steiger, and L. Schlender. 1999. Humpback and blue whale photo-identification research off California, Oregon and Washington in 1998. Final Contract Report to Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 35 pp.

Calambokidis, J., T. Chandler, K. Rasmussen, L. Schlender, and G. H. Steiger. 2000. Humpback and blue whale photo-identification research off California, Oregon and Washington in 1999. Final Contract Report to Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.pp.

Calambokidis, J., T. Chandler, L. Schlender, K. Rasmussen, and G. H. Steiger. 2001. Research on humpback and blue whales off California, Oregon, and Washington in 2000. Contract Report to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 32pp.

Calambokidis, J., and G. H. Steiger. 1994. Population assessment of humpback and blue whales using photo-identification from 1993 surveys off California. Final Contract Report to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 31pp.

Calambokidis, J., G. H. Steiger, and J. R. Evenson. 1993. Photographic identification and abundance estimates of humpback and blue whales off California in 1991-92. Final Contract Report 50ABNF100137 to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 67pp.

Calambokidis, J., G. H. Steiger, J. R. Evenson, K. R. Flynn, K. C. Balcomb, D. E. Claridge, P. Bloedel, J. M. Straley, C. S. Baker, O. von Ziegesar, M. E. Dahlheim, J. M. Waite, J. D. Darling, G. Ellis, and G. A. Green. 1996. Interchange and isolation of humpback whales in California and other North Pacific feeding grounds. Mar. Mamm. Sci. 12(2):215-226.

Calambokidis, J., G. H. Steiger, J. M. Straley, T. J. Quinn, II, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. Urbán R., J. Jacobsen, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, N. Higashi, S. Uchida, J. K. B. Ford, Y. Miyamura, P. Ladrón de Guevara P., S. A. Mizroch, L. Schlender and K. Rasmussen. 1997. Abundance and population structure of humpback whales in the North Pacific Basin. Final Contract Report 50ABNF500113 to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 72p.

Calambokidis, J., G. H. Steiger, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urbán-R., J. K. Jacobsen, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P. Ladrón de Guevara-P., M. Yamaguchi, F. Sata, S. A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow, and T. J. Quinn II. 2001. Movements and population structure of humpback whales in the North Pacific. Mar. Mamm. Sci. 17(4):769-794.

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 (unpublished). 14 pp.

Cameron, G.A. and K.A. Forney. 2000. Preliminary estimates of cetacean mortality in the California/Oregon gillnet fisheries for 1999. Paper SC/52/O24 presented to the International Whaling Commission (unpublished). 12

Carretta, J.V. 2001. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2000. Paper SC/53/SM9 presented to the International Whaling Commission (unpublished). 21 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.

Darling, J. D. 1991. Humpback whales in Japanese waters. Ogasawara and Okinawa. Fluke identification catalog 1987-1990. Final Contract Report, World Wildlife Fund for Nature, Japan. 22 pp.

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.

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.

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.

Hammond, P. S. 1986. Estimating the size of naturally marked whale populations using capture-recapture techniques. Rept. Int. Whal. Commn., Special Issue 8:253-282.

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. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, Megaptera novaeangliae. Mar. Fish. Rev. 46(4):30-37.

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.

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results. Pp. 172-191 *In:* K. S. Norris (ed.), Whales, Dolphins and Porpoises. University of California Press, Berkeley, CA. Academic Press, New York.

Norris, T. F., M. McDonald, and J. Barlow. 1999. Acoustic detections of singing humpback whales (Megaptera novaeangliae) in the eastern North Pacific during their northbound migration. J. Acoust. Soc. Am. 106(1):506-514.

Perry, A., C. S. Baker, L. M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: a summary and critique. Rep. Int. Whal. Commn. (Special Issue 12):307-317.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

Rice, D. W. 1978. The humpback whale in the North Pacific: distribution, exploitation, and numbers. pp. 29-44 In: K. S. Norris and R. R. Reeves (eds.). Report on a Workshop on Problems Related to Humpback Whales (Megaptera novaeangliae) in Hawaii. Contr. Rept. to U. S. Marine Mammal Commn. NTIS PB-280-794. 90pp.

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.

Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mamm. Sci. 7:306-310.

Tonnessen, J. N., and A. O. Johnsen. 1982. The History of Modern Whaling. Univ. Calif. Press, Berkeley and Los Angeles. 798pp.7:306-310.

Urbán R., J., C. Alverez F., M. Salinas Z., J. Jacobson, K. C. Balcomb III, A. Jaramillo L., P. L. de Guevara P., and A. Aguayo L. 1999. Population size of humpback whale, *Megaptera novaeangliae*, in waters off the Pacific coast of Mexico.

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BLUE WHALE (*Balaenoptera musculus*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) has formally considered only one management stock for blue whales in the North Pacific (Donovan 1991), but now this ocean is thought to include more than one population (Ohsumi and Wada 1972; Braham 1991), possibly as many as five (Reeves et al. 1998). This report covers one population that feeds in California waters in summer/fall (from June to November) and migrates south to productive areas off Mexico (Calambokidis et al. 1990) and as far south as the Costa Rica Dome (10° N) (Mate et al. 1999; Calambokidis, pers. comm.) in winter/spring. Blue whales are occasionally seen or heard off Oregon (McDonald et al. 1994, Stafford et al. 1998; VonSaunder and Barlow 1999), but sightings there are rare. Reilly and Thayer (1990) speculate that blue whales found near the Costa Rica Dome from June to November are likely to be part of a southern hemisphere population or an isolated resident population; however, based on acoustic call similarities, Stafford et al. (1999) linked these animals to the population that feeds off California at the same time of year. Rice (1974) hypothesized that blue whales from Baja California migrated far offshore to fed in the eastern Aleutians or Gulf of Alaska and returned to feed in California waters; however, he has more recently concluded that the California population is separate from the Gulf of Alaska population (Rice 1992). Recently, blue whale feeding aggregations have not been found in Alaska despite several surveys (Leatherwood et al. 1982; Stewart et al. 1987; Forney and Brownell 1996). One other stock of North Pacific blue whales (in Hawaiian waters) is recognized in the Marine Mammal Protection Act (MMPA) Stock Assessment Reports.

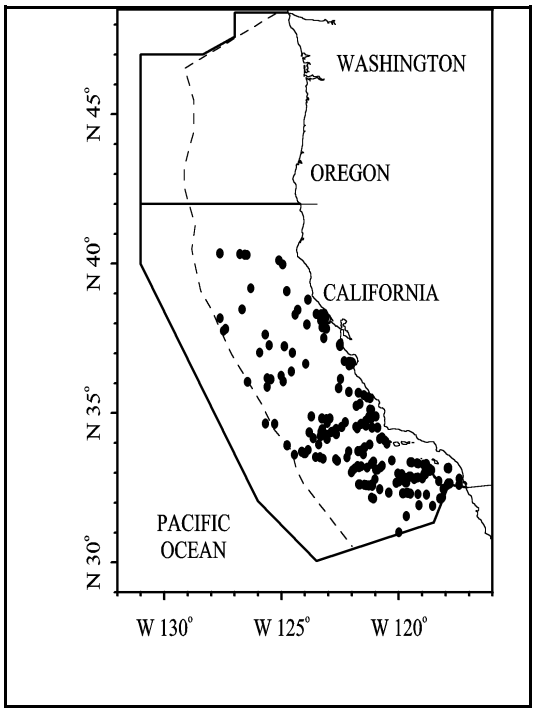

Figure 1. Blue whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1991-96(see Appendix 2, Figures 1-5, for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

POPULATION SIZE

The size of the feeding stock of blue whales in California was estimated recently by both line-transect and mark-recapture methods. Barlow (1997) estimates 1,927 (CV=0.16) blue whales off California, Oregon, and Washington based on ship line-transect surveys in 1991-96. Calambokidis and Steiger (1994) used photographic mark-recapture and estimated population sizes of 2,038 (CV=0.33) based on photographs of left sides and 1,997 (CV=0.42) based on right sides. The average of the mark-recapture estimates (2,017, CV=0.38) is in surprisingly good agreement with the line-transect estimate. Mark-recapture estimates are often negatively biased by individual heterogeneity in sighting probabilities (Hammond 1986); however, Calambokidis and Steiger (1994) minimize such effects by selecting one sample that was taken randomly with respect to distance from the coast. Similarly, the line-transect estimates may also be negatively biased because some blue whales in this stock are probably along Baja California and, therefore, out of the study area at the time of survey (Wade and Gerrodette 1993). The best estimate of blue whale abundance is the average of the line-transect and mark-recapture estimates, weighted by their variances, or 1,940 (CV=0.15).

Minimum Population Estimate

The minimum population estimate for blue whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from the combined mark-recapture and line-transect estimates, or approximately 1,716.

Current Population Trend

There is some indication that blue whales have increased in abundance in California coastal waters between 1979/80 and 1991 (regression $p<0.05$, Barlow 1994) and between 1991 and 1996 (not significant, Barlow 1997). Although this may be due to an increase in the stock as a whole, it could also be the result of an increased use of California as a feeding area. The size of the apparent increase abundance seen by Barlow (1994) is too large to be accounted for by population growth alone. Also, Larkman and Veit (1998) did not detect any increase along consistently surveyed tracklines in the Southern California Bight from 1987 to 1995. Although the population in the North Pacific is expected to have grown since being given protected status in 1966, the possibility of continued unauthorized takes after blue whales were protected (Yablokov 1994) and the existence of incidental ship strikes and gillnet mortality makes this uncertain.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information exists on the rate of growth of blue whale populations in the Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,716) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of 3.4 . Because this stock spends approximately half its time outside the U.S. EEZ, the PBR allocation for U.S. waters is half this total, or 1.7 whales per year.

HUMAN CAUSED MORTALITY

Historic Whaling

The reported take of North Pacific blue whales by commercial whalers totaled 9,500 between 1910 and 1965 (Ohsumi and Wada 1972). Approximately 2,000 were taken off the west coast of North America between 1919 and 1929 (Tonnessen and Johnsen 1982). Partially overlapping with this is Rice's (1992) report of at least 1,378 taken by factory ships off California and Baja California between 1913 and 1937. Between 1947 and 1987, reported takes of blue whales in the North Pacific were approximately 2,400. Shore-based whaling stations in central California took 3 blue whales between 1919 and 1926 (Clapham et al. 1997) and 48 blue whales between 1958 and 1965 (Rice 1974). Blue whales in the North Pacific were given protected status by the IWC in 1966.

Fisheries Information

The offshore drift gillnet fishery is the only fishery that is likely to take blue whales from this stock, but no fishery mortalities or serious injuries have been observed (Table 1). Detailed information on this fishery is provided in Appendix 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). 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 1997-98 data. This results in an average estimate of zero blue whales taken annually. Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net; however, fishermen report that large rorquals (blue and fin whales) usually swim through nets without entangling and with very little damage to the nets.

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.).

Table 1. Summary of available information on the incidental mortality and injury of blue whales (Eastern North Pacific stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999). Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1994-98	observer data	12-23%	0,0,0,0,0	0,0,0,0,0	0[1]
Total annual takes						0

[1] Only 1997-98 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).

Ship Strikes

Ship strikes were implicated in the deaths of blue whales in 1980, 1986, 1987, and 1993 (J. Cordaro, Southwest Region, NMFS and J. Heyning, pers. comm.). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. Several blue whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (J. Calambokidis, pers. comm.). The average number of blue whale mortalities in California attributed to ship strikes was 0.0 per year for 1994-98.

STATUS OF STOCK

Previously, blue whales in the entire North Pacific were estimated to be at 33% (1,600 out of 4,900) of historic carrying capacity (Mizroch et al. 1984). The initial abundance has never been estimated separately for the "California" stock, but this stock was almost certainly depleted by whaling. Blue whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the Eastern North Pacific stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The annual incidental mortality from ship strikes is apparently less than the calculated PBR for this stock. To date, no blue whale mortality has been associated with California gillnet fisheries; therefore, total fishery mortality is approaching zero mortality and serious injury rate. The population appears to be growing. The increasing levels of anthropogenic noise in the world's oceans has been suggested to be a habitat concern for blue whales (Reeves et al. 1998).

REFERENCES

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. 1997. Preliminary estimates of cetacean abundance off California, Oregon, and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Admin. Rept. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 25 pp.

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.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Braham, H. W. 1991. Endangered whales: status update. A Report on the 5-year status of stocks review under the 1978 amendments to the U.S. Endangered Species Act. NMFS Unpublished Report.

Calambokidis, J., and G. H. Steiger. 1994. Population assessment of humpback and blue whales using photo-identification from 1993 surveys off California. Final Contract Report to Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 31 pp.

Calambokidis, J., G. H. Steiger, J. C. Cubbage, K. C. Balcomb, C. Ewald, S. Kruse, R. Wells, and R. Sears. 1990.

Sightings and movements of blue whales off central California 1986-88 from photo-identification of individuals. Rept. Int. Whal. Commn., Special Issue 12:343-348.
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. Mar. Mamm. Sci. 13(3):368-394.
Donovan, G. P. 1991. A review of IWC stock boundaries. Rept. Int. Whal. Commn., Special Issue 13:39-68.
Forney, K. A. and R. L. Brownell, Jr. 1996. Preliminary report of the 1994 Aleutian Island marine mammal survey. Paper SC/48/O11 presented to the International Whaling Commission.
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.
Hammond, P. S. 1986. Estimating the size of naturally marked whale populations using capture-recapture techniques. Rept. Int. Whal. Commn., Special Issue 8:253-282.
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. Rep. LJ-86-16. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 55 pp.
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. 95 pp.
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. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.
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 p.
Julian, F. 1997. Cetacean mortality in the California gill net fisheries: preliminary estimates for 1996. Paper SC/49/SM2 presented to the International Whaling Commission, September 1997 (unpublished). 13 pp.
Julian, F. and M. Beeson. 1998. Estimates for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fish. Bull. 96:271-284.
Larkman, V. E. and R. R. Veit. 1998. Seasonality and abundance of blue whales off southern California. CalCOFI Rep. 39:236-239.
Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. NOAA Technical Rept. NMFS Circular 444. 245 pp.
Mate, B. R., B. A. Lagerquist, and J. Calambokidis. 1999. Movements of North Pacific blue whales during their feeding season off southern California and their southern fall migration. Mar. Mamm. Sci. 15(4):1246-1257.
McDonald, M. A., J. A. Hildebrand, and S. C. Webb. 1994. Blue and fin whales observer on a seafloor array in the Northeast Pacific. (unpubl. ms.).
Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984. The blue whale, Balaenoptera musculus. Mar. Fish. Rev. 46:15-19.
Ohsumi, S. and S. Wada. 1972. Stock assessment of blue whales in the North Pacific. Working Paper for the 24th Meeting of the International Whaling Commission. 20 pp.
Reilly, S. B. and V. G. Thayer. 1990. Blue whale (Balaenoptera musculus) distribution in the eastern tropical Pacific. Mar. Mamm. Sci. 6(4):265-277.
Reeves, R. R., P. J. Clapham, R. L. Brownell, Jr., and G. K. Silber. 1998. Recovery plan for the blue whale (Balaenoptera musculus). Office of Protected Resources, NMFS, NOAA, Silver Spring, Maryland. 30 pp.
Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.
Rice, D. W. 1992. The blue whales of the southeastern North Pacific Ocean. pp. 1-3 In. Alaska Fisheries Science

Center, Quart. Rept. Oct.-Dec.
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.
Stafford, K. M., C. G. Fox, and D. S. Clark. 1998. Long-range acoustic detection and localization of blue whale calls in the northeast Pacific Ocean. J. Acoust. Soc. Am. 104(6):3616-3625.
Stafford, K. M., S. L. Nieukirk, and C. G. Fox. 1999. An acoustic link between blue whales in the eastern tropical Pacific and the Northeast Pacific. Mar. Mamm. Sci. 15(4):1258-1268.
Stewart, B. S., S. A. Karl, P. K. Yochem, S. Leatherwood, and J. L. Laake. 1987. Aerial surveys for cetaceans in the former Akutan, Alaska, whaling grounds. Arctic 40(1):33-42.
Tonnessen, J. N., and A. O. Johnsen. 1982. The History of Modern Whaling. Univ. Calif. Press, Berkeley and Los Angeles. 798 pp.
Von Saunder, A. and J. Barlow. 1999. A report of the Oregon, California and Washington Line-transect Experiment (ORCAWALE) conducted in west coast waters during summer/fall 1996. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-264. 40 pp.
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.
Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

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FIN WHALE (*Balaenoptera physalus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) recognized two stocks of fin whales in the North Pacific: the East China Sea and the rest of the North Pacific (Donovan 1991). Mizroch et al. (1984) cites evidence for additional fin whale subpopulations in the North Pacific. From whaling records, fin whales that were marked in winter 1962-70 off southern California were later taken in commercial whaling operations between central California and the Gulf of Alaska in summer (Mizroch et al. 1984). More recent observations show aggregations of fin whales year-round in southern/central California (Dohl et al. 1983; Barlow 1997; Forney et al. 1995), year-round in the Gulf of California (Tershy et al. 1993), in summer in Oregon (Green et al. 1992; McDonald 1994), and in summer/autumn in the Shelikof Strait/Gulf of Alaska (Brueggeman et al. 1990). Acoustic signals from fin whale are detected year-round off northern California, Oregon and Washington, with a concentration of vocal activity between September and February (Moore et al. 1998). Fin whales appear very scarce in the eastern tropical Pacific in summer (Wade and Gerrodette 1993) and winter (Lee 1993).

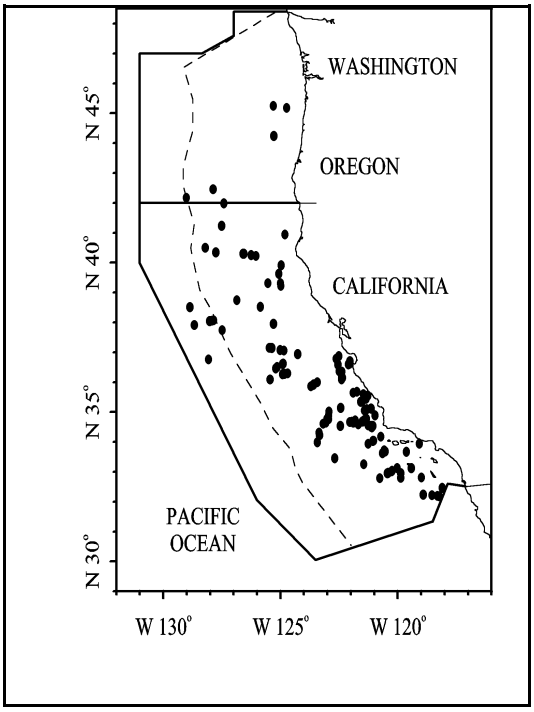

Figure 1. Fin whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1991-96 (see Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

There is still insufficient information to accurately determine population structure, but from a conservation perspective it may be risky to assume panmixia in the entire North Pacific. In the North Atlantic, fin whales were locally depleted in some feeding areas by commercial whaling (Mizroch et al. 1984), in part because subpopulations were not recognized. This assessment will cover the stock of fin whales which is found along the coasts of California, Oregon, and Washington. Because fin whale abundance appears lower in winter/spring in California (Dohl et al. 1983; Forney et al. 1995) and in Oregon (Green et al. 1992), it is likely that the distribution of this stock extends seasonally outside these coastal waters. Coincidentally, fin whale abundance in the Gulf of California increases seasonally in winter and spring (Tershy et al. 1993). It is premature, however, to conclude that the Gulf whales are part of the U.S. west coast population. The Marine Mammal Protection Act (MMPA) stock assessment reports recognize three stocks of fin whales in the North Pacific: 1) the California/Oregon/Washington stock (this report), 2) the Hawaii stock, and 3) the Alaska stock.

POPULATION SIZE

The initial pre-whaling population of fin whales in the North Pacific was estimated to be 42,000-45,000 (Ohsumi and Wada 1974). In 1973, the North Pacific population was estimated to have been reduced to 13,620-18,680 (Ohsumi and Wada 1974), of which 8,520-10,970 were estimated to belong to the eastern Pacific stock. A minimum of 148 individually-identified fin whales are found in the Gulf of California (Tershy et al. 1990). Recently,1,851 (CV=0.19) fin whales were estimated to be off California, Oregon and Washington based on ship surveys in summer/autumn of 1993 and 1996 (Barlow and Taylor 2001). This is probably a slight underestimate because it almost certainly excludes some fin whales which could not be identified in the field and which were recorded as “unidentified rorqual” or “unidentified large whale”.

Minimum Population Estimate

The minimum population estimate for fin whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from summer/fall ship survey (Barlow and Taylor 2001) or approximately 1,581.

Current Population Trend

There is some indication that fin whales have increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1994) and between 1991 and 1996 (Barlow 1997), but these trends are not significant. Although the population in the North Pacific is expected to have grown since receiving protected status in 1976, the possible effects of continued unauthorized take (Yablokov 1994) and incidental ship strikes and gillnet mortality make this uncertain.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of fin whale populations in the North Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,581) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of 3.2.

HUMAN CAUSED MORTALITY

Historic Whaling

Approximately 46,000 fin whales were taken from the North Pacific by commercial whalers between 1947 and 1987 (C. Allison, IWC, pers. comm.), including 1,060 fin whales taken by coastal whalers in central California between 1958 and 1965 (Rice 1974). In addition, approximately 3,800 were taken off the west coast of North America between 1919 and 1929 (Tonnessen and Johnsen 1982), and 177 were taken by coastal whalers off California between 1919 and 1926 (Clapham et al. 1997). Fin whales in the North Pacific were given protected status by the IWC in 1976.

Fisheries Information

The offshore drift gillnet fishery is the only fishery that is likely to take fin whales from this stock, and one fin whale death has been observed (Table 1). Detailed information on this fishery is provided in Appendix 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). 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. This results in an average estimate of 1.5 fin whales taken annually. Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net; however, fishermen report that large rorquals (blue and fin whales) usually swim through nets without entangling and with very little damage to the nets.

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.).

Table 1. Summary of available information on the incidental mortality and injury of fin whales (CA/OR/WA stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999, 2000).

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1995-99	observer data	12-23%	0,0,0,0,1	0,0,0,0,4.5	1.5 [1]
Average annual takes						1.5

[1] 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).

Ship Strikes

Ship strikes were implicated in the deaths of one fin whale in 1991, one in 1996, and one in 1997 (J. Heyning and J. Cordaro, Southwest Region, NMFS, pers. comm.). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. The average observed annual mortality due to ship strikes is 0.4 fin whales per year for the period 1995-99.

STATUS OF STOCK

Fin whales in the entire North Pacific were estimated to be at less than 38% (16,625 out of 43,500) of historic carrying capacity (Mizroch et al. 1984). The initial abundance has never been estimated separately for the "west coast" stock, but this stock was also probably depleted by whaling. Fin 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 total incidental mortality due to fisheries (1.5/yr) and ship strikes (0.4/yr) appears to be less than the calculated PBR (3.2). Total fishery mortality is greater than 10% of PBR and, therefore, may not be approaching zero mortality and serious injury rate. There is some indication that the population may be growing. The increasing levels of anthropogenic noise in the world's oceans has been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound.

REFERENCES

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. 1997. Preliminary estimates of cetacean abundance off California, Oregon, and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Admin. Rept. LJ-97-11 available from Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA. 25 pp.

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. 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. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Brueggeman, J. J., G. A. Green, K. C. Balcomb, C. E. Bowlby, R. A. Grotefendt, K. T. Briggs, M. L. Bonnell, R. G. Ford, D. H. Varoujean, D. Heinemann, and D. G. Chapman. 1990. Oregon-Washington Marine Mammal and Seabird Survey: Information synthesis and hypothesis formulation. U.S. Department of the Interior, OCS Study MMS 89-0030.

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.

Cameron, G.A. and K.A. Forney. 2000. Preliminary estimates of cetacean mortality in the California/Oregon gillnet fisheries for 1999. Paper SC/52/O24 presented to the International Whaling Commission, June 2000 (unpublished). 12 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. Mar. Mamm. Sci. 13(3):368-394.

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.

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. Dep. Commer. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-300. 276p.

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. 95p.

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. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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, 276p.

Julian, F. 1997. Cetacean mortality in the California gill net fisheries: preliminary estimates for 1996. Paper SC/49/SM2 presented to the International Whaling Commission, September 1997 (unpublished). 13pp.

Julian, F. and M. Beeson. 1998. Estimates for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fish. Bull. 96:271-284.

Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-181. 184 pp.

McDonald, M. A., J. A. Hildebrand, and S. C. Webb. 1994. Blue and fin whales observer on a seafloor array in the Northeast Pacific. (unpubl. ms.).

Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984. The fin whale, Balaenoptera physalus. Mar. Fish. Rev. 46:20-24.

Moore, S. E., K. M. Stafford, M. E. Dahlheim, C. G. Fox, H. W. Braham, J. J. Polovina, and D. E. Bain. 1998. Seasonal variation in reception of fin whale calls at five geographic areas in the North Pacific. Mar. Mamm. Sci. 14(3):617-627.

Ohsumi, S. and S. Wada. 1974. Status of whale stocks in the North Pacific, 1972. Rept. Int. Whal. Commn. 25:114-126.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

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.

Tershy, B. R., D. Breese, and C. S. Strong. 1990. Abundance, seasonal distribution and population composition of balaenopterid whales in the Canal de Ballenas, Gulf of California, Mexico. Rept. Int. Whal. Commn., Special Issue 12:369-375.

Tershy, B. R., J. Urbán-R., D. Breese, L. Rojas-B., and L. T. Findley. 1993. Are fin whales resident to the Gulf of California? Rev. Invest. Cient., Univ. Auton. de Baja California Sur. 1:69-71.

Tonnessen, J. N., and A. O. Johnsen. 1982. The History of Modern Whaling. Univ. Calif. Press, Berkeley and Los Angeles. 798pp.

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.

Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

Revised 12/15/2000

BRYDE'S WHALE (*Balaenoptera edeni*): Eastern Tropical Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) recognizes 3 stocks of Bryde's whales in the North Pacific (eastern, western, and East China Sea), 3 stocks in the South Pacific (eastern, western and Solomon Islands), and one cross-equatorial stock (Peruvian) (Donovan 1991). Bryde's whales are distributed widely across the tropical and warm-temperate Pacific (Leatherwood et al. 1982), and there is no real justification for splitting stocks between the northern and southern hemispheres (Donovan 1991). Recent surveys (Lee 1993; Wade and Gerrodette 1993) have shown them to be common and distributed throughout the eastern tropical Pacific with a concentration around the equator east of 110°W (corresponding approximately to the IWC's "Peruvian stock") and a reduction west of 140°W. They are also the most common baleen whale in the central Gulf of California (Tershy et al. 1990). Only one was positively identified in surveys of California coastal waters (Barlow 1997). Bryde's whales in California are likely to belong to a larger population inhabiting at least the eastern part of the tropical Pacific. For the Marine Mammal Protection Act (MMPA) stock assessment reports, Bryde's whales within the Pacific U.S. Exclusive Economic Zone are divided into two areas: 1) the eastern tropical Pacific (east of 150°W and including the Gulf of California and waters off California; this report), and 2) Hawaiian waters.

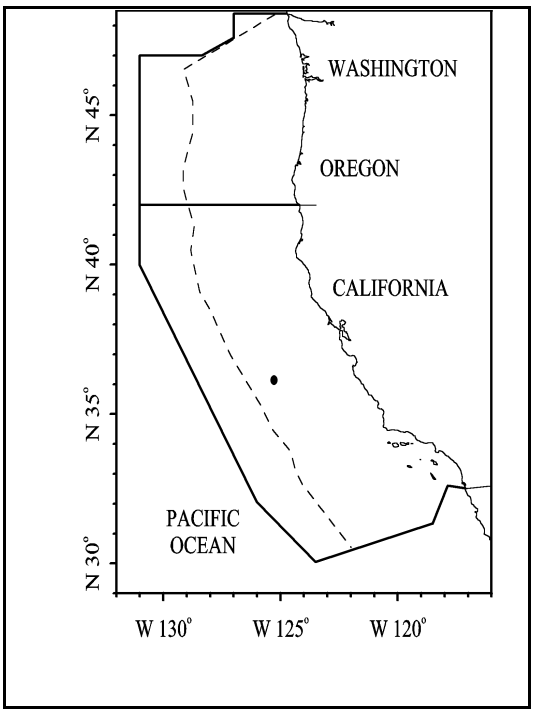

Figure 1. Sighting locations of Bryde's whales based on aerial and shipboard surveys off California, Oregon, and Washington, 1991-96 (see Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

POPULATION SIZE

In the western North Pacific, Bryde's whale abundance in the early 1980s was estimated independently by tag mark-recapture and ship survey methods to be 22,000 to 24,000 (Tillman and Mizroch 1982; Miyashita 1986). Bryde's whale abundance has never been estimated for the entire eastern Pacific; however, a portion of that stock in the eastern tropical Pacific was estimated recently as 13,000 (CV=0.20; 95% C.I.=8,900-19,900) (Wade and Gerrodette 1993), and the minimum number in the Gulf of California is 160 based on individually-identified whales (Tershy et al. 1990). Only one confirmed sighting of Bryde's whales and five possible sightings (identified as sei or Bryde's whales) were made in California waters during extensive ship and aerial surveys in 1991, 1992, 1993, and 1996 (Hill and Barlow 1992; Carretta and Forney 1993; Mangels and Gerrodette 1994; VonSaunder and Barlow 1999). Green et al. (1992) did not report any sightings of Bryde's whales in aerial surveys off Oregon and Washington. The estimated abundance of Bryde's whales in California, Oregon, and Washington coastal waters is 12 (CV=2.0) (Barlow 1997).

Minimum Population Estimate

The minimum population estimate for Bryde's whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from the summer/fall ship surveys in 1986-90 (Wade and Gerrodette 1993) plus the minimum of 160 whales counted in the Gulf of California (Tershy et al. 1990), or 11,163.

Current Population Trend

There are no data on trends in Bryde's whale abundance in the eastern tropical Pacific.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of Bryde's whale populations in the Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock cannot be calculated because the only relevant abundance estimate (Wade and Gerrodette 1993) is more than 8 years old. Additional data on the abundance of Bryde's whales in the eastern Pacific was gathered in 1998-99, but their abundance has not yet been estimated from those data.

HUMAN CAUSED MORTALITY

Historic Whaling

The reported take of North Pacific Bryde's whales by commercial whalers totaled 15,076 in the western Pacific from 1946-1983 (Holt 1986) and 2,873 in the eastern Pacific from 1973-81 (Cooke 1983). In addition, 2,304 sei-or-Bryde's whales were taken in the eastern Pacific from 1968-72 (Cooke 1983) (based on subsequent catches, most of these were probably Bryde's whales). None were reported taken by shore-based whaling stations in central or northern California between 1919 and 1926 (Clapham et al. 1997) or 1958 and 1965 (Rice 1974). There has been a prohibition on taking Bryde's whales since 1988.

Table 1. Summary of available information on the incidental mortality and injury of Bryde's whales (eastern tropical Pacific stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999). 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	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1994-98	observer data	12-23%	0,0,0,0,0	0,0,0,0,0	0[1]
Mexico thresher shark/swordfish drift gillnet fishery	1991-95	observer data	n/a	n/a	n/a	n/a
					Total annual takes	0

[1] Only 1997-98 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).

Fishery Information

The offshore drift gillnet fishery is the only fishery that is likely to take Bryde's whales from this stock, but no fishery mortalities or serious injuries have been observed (Table 1). Detailed information on this fishery is provided in Appendix 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). 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 1997-98 data. This results in an average estimate of zero Bryde's whales taken annually. However, some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net.

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

Ship strikes may occasionally kill Bryde's whales as they are known to kill their larger relatives: blue and fin whales. No ship strikes have been reported for this species in this area.

STATUS OF STOCK

Commercial whaling of Bryde's whales was largely limited to the western Pacific. Bryde's whales are not listed as "threatened" or "endangered" under the Endangered Species Act (ESA). Bryde's whales in the eastern tropical Pacific would not be considered a strategic stock under the MMPA. The total human-caused mortality rate is estimated to be zero; therefore, under the MMPA, total fishery mortality is 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 baleen whales that may communicate using low-frequency sound.

REFERENCES

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. Admin. Rept. LJ-97-11 available from Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA. 25pp.

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.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

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.

Carretta, J. V. and K. A. Forney. 1993. Report on two aerial surveys for marine mammals in California coastal waters utilizing a NOAA DeHavilland Twin Otter Aircraft: March 9-April7, 1991 and February 8-April 6, 1992. NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-185. 77pp.

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. Mar. Mamm. Sci. 13(3):368-394.

Cooke, J. G. 1983. Estimates of the stock of Bryde's whales fished off the coast of Peru. Rept. Int. Whal. Commn. 33:453-456.

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

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.

Hill, P. S. and J. Barlow. 1992. Report of a marine mammal survey of the California coast aboard the research vessel McARTHUR July 28-November 5, 1991. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-169. NTIS #PB93-109908. 103pp.

Holt, S. 1986. Aspects of the assessment and regulation of Bryde's whales in the Northwest Pacific. Rept. Int. Whal.

Commn. 36:257-262.
Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.
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 p.
Julian, F. 1997. Cetacean mortality in the California gill net fisheries: preliminary estimates for 1996. Paper SC/49/SM2 presented to the International Whaling Commission, September 1997 (unpublished). 13pp.
Julian, F. and M. Beeson. 1998. Estimates for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fish. Bull. 96:271-284.
Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. NOAA Technical Rept. NMFS Circular 444. 245 pp.
Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-181. 184 pp.
Mangels, K. F. and T. Gerrodette. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and the Gulf of California aboard the NOAA ships *McArthur* and *David Starr Jordan* July 28 - November 6, 1993. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-221. 88 pp.
Miyashita, T. 1986. Sighting estimate for the Bryde's whale stock in the western North Pacific. Rept. Int. Whal. Commn. 36:249-252.
Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.
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.
Tershy, B. R., D. Breese, and C. S. Strong. 1990. Abundance, seasonal distribution and population composition of balaenopterid whales in the Canal de Ballenas, Gulf of California, Mexico. Rept. Int. Whal. Commn., Special Issue 12:369-375.
Tillman, M. F. and S. A. Mizroch. 1982. Mark-recapture estimates of abundance for the western Northern Pacific stock of Bryde's whales. Rept. Int. Whal. Commn. 32:335-337.
Von Saunder, A. and J. Barlow. 1999. A report of the Oregon, California and Washington Line-transect Experiment (ORCAWALE) conducted in west coast waters during summer/fall 1996. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-264. 40 pp.
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.

Revised 12/15/2000

SEI WHALE (*Balaenoptera borealis*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) only considers one stock of sei whales in the North Pacific (Donovan 1991), but some evidence exists for multiple populations (Masaki 1977; Mizroch et al. 1984; Horwood 1987). Sei whales are distributed far out to sea in temperate regions of the world and do not appear to be associated with coastal features. Whaling effort for this species was distributed continuously across the North Pacific between 45-55°N (Masaki 1977). Two sei whales that were tagged off California were later killed off Washington and British Columbia (Rice 1974) and the movement of tagged animals has been noted in many other regions of the North Pacific. Sei whales are now rare in California waters (Dohl et al. 1983; Barlow 1997; Forney et al. 1995; Mangels and Gerrodette 1994), but were the fourth most common whale taken by California coastal whalers in the 1950s-1960s (Rice 1974). They are extremely rare south of California (Wade and Gerrodette 1993; Lee 1993). Lacking additional information on sei whale population structure, sei whales in the eastern North Pacific (east of longitude 180°) will be considered as a separate stock.

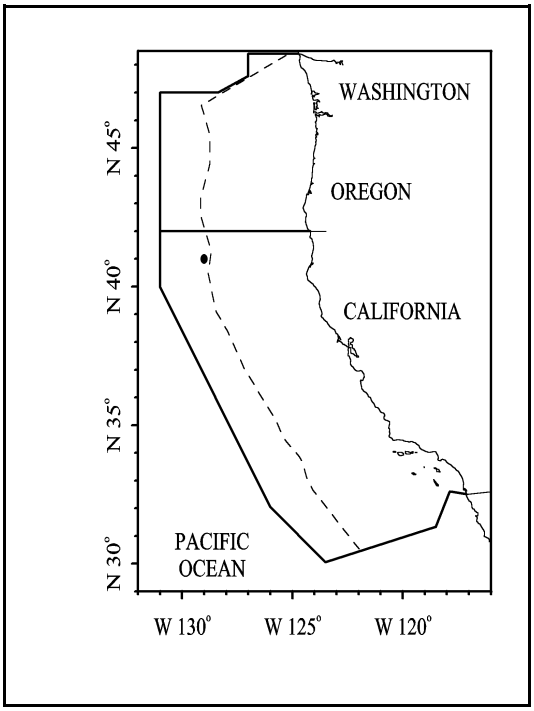

Figure 1. Sei whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1991-96 (see Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

POPULATION SIZE

Ohsumi and Wada (1974) estimate the pre-whaling abundance of sei whales to be 58,000-62,000 in the North Pacific. Later, Tillman (1977) used a variety of different methods to estimate the abundance of sei whales in the North Pacific and revised this pre-whaling estimate to 42,000. His estimates for the year 1974 ranged from 7,260 to 12,620. All methods depend on using the history of catches and trends in CPUE or sighting rates; there have been no direct estimates of sei whale abundance in the entire (or eastern) North Pacific based on sighting surveys. Only one confirmed sighting of sei whales and 5 possible sightings (identified as sei or Bryde's whales) were made in California waters during extensive ship and aerial surveys in 1991, 1992, 1993, and 1996 (Hill and Barlow 1992; Carretta and Forney 1993; Mangels and Gerrodette 1994; VonSaunder and Barlow 1999). Green et al. (1992) did not report any sightings of sei whales in aerial surveys of Oregon and Washington. There are no abundance estimates for sei whales along the west coast of the U.S. or in the eastern North Pacific.

Minimum Population Estimate

Minimum population estimates do not exist for sei whales in the eastern North Pacific.

Current Population Trend

There are no data on trends in sei whale abundance in the eastern North Pacific waters. Although the population in the North Pacific is expected to have grown since being given protected status in 1976, the possible effects of continued unauthorized take (Yablokov 1994) and incidental ship strikes and gillnet mortality make this uncertain.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of sei whale populations in the North Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

No estimate exists for the minimum abundance of the eastern North Pacific stock of sei whales. Estimates for the entire North Pacific are more than 10 years old and do not include statistical estimates of precision. Consequently, PBR levels cannot be calculated.

HUMAN CAUSED MORTALITY

Historic Whaling

The reported take of North Pacific sei whales by commercial whalers totaled 61,500 between 1947 and 1987 (C. Allison, IWC, pers. comm.). Of these, 384 were taken by-shore-based whaling stations in central California between 1958 and 1965 (Rice 1974). An additional 26 were taken off central and northern California between 1919 and 1926 (Clapham et al. 1997). There has been an IWC prohibition on taking sei whales since 1976, and commercial whaling in the U.S. has been prohibited since 1972.

Fishery Information

The offshore drift gillnet fishery is the only fishery that is likely to take sei whales from this stock, but no fishery mortalities or serious injuries have been observed (Table 1). Detailed information on this fishery is provided in Appendix 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). 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 1997-98 data. This results in an average estimate of zero sei whales taken annually. However, some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net.

Table 1. Summary of available information on the incidental mortality and injury of sei whales (eastern North Pacific stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999). 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	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1994-98	observer data	12-23%	0,0,0,0,0	0,0,0,0,0	0[1]
Total annual takes						0

[1] Only 1997-98 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).

Ship Strikes

Ship strikes may occasionally kill sei whales as they have been shown to kill their larger relatives: blue and fin whales. No ship strikes have been reported for this species in this area.

STATUS OF STOCK

Previously, sei whales were estimated to have been reduced to 20% (8,600 out of 42,000) of their pre-whaling abundance in the North Pacific (Tillman 1977). The initial abundance has never been reported separately for the eastern North Pacific stock, but this stock was also probably depleted by whaling. Sei whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the eastern North Pacific stock is automatically considered as a "depleted" and "strategic" stock under the Marine Mammal Protection Act (MMPA). Total estimated fishery mortality is zero and therefore is “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 baleen whales that may communicate using low-frequency sound.

REFERENCES

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. Admin. Rept. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 25 pp.

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.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Carretta, J. V. and K. A. Forney. 1993. Report on two aerial surveys for marine mammals in California coastal waters utilizing a NOAA DeHavilland Twin Otter Aircraft: March 9-April7, 1991 and February 8-April 6, 1992. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-185. 77 pp.

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. Mar. Mamm. Sci. 13(3):368-394.

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. 284 pp.

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

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.

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. Southwest Fisheries Science Center, National Marine Fisheries Service, 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.

Hill, P. S. and J. Barlow. 1992. Report of a marine mammal survey of the California coast aboard the research vessel McARTHUR July 28-November 5, 1991. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-169. 103 pp.

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 p.

Horwood, J. 1987. The Sei Whale: Population Biology, Ecology and Management. Croom Helm, London, U.K. 375pp.

Julian, F. 1997. Cetacean mortality in the California gill net fisheries: preliminary estimates for 1996. Paper SC/49/SM2 presented to the International Whaling Commission, September 1997 (unpublished). 13pp.

Julian, F. and M. Beeson. 1998. Estimates for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fish. Bull. 96:271-284.

Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-181. 184 pp.

Mangels, K. F. and T. Gerrodette. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and the Gulf of California aboard the NOAA ships *McArthur* and *David Starr Jordan* July 28 -

November 6, 1993. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-221. 88 pp.
Masaki, Y. 1977. The separation of the stock units of sei whales in the North Pacific. Rept. Int. Whal. Commn., Special Issue 1:71-77.
Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984. The sei whale, Balaenoptera borealis. Mar. Fish. Rev. 46:25-29.
Ohsumi, S. and S. Wada. 1974. Status of whale stocks in the North Pacific, 1972. Rept. Int. Whal. Commn. 25:114-126.
Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.
Tillman, M. F. 1977. Estimates of population size for the North Pacific sei whale. Rept. Int. Whal. Commn., Special Issue 1:98-106.
Von Saunder, A. and J. Barlow. 1999. A report of the Oregon, California and Washington Line-transect Experiment (ORCAWALE) conducted in west coast waters during summer/fall 1996. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-264. 40 pp.
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.
Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

Revised 12/15/2000

MINKE WHALE (*Balaenoptera acutorostrata*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) recognizes 3 stocks of minke whales in the North Pacific: one in the Sea of Japan/East China Sea, one in the rest of the western Pacific west of 180°N, and one in the "remainder" of the Pacific (Donovan 1991). The "remainder" stock only reflects the lack of exploitation in the eastern Pacific and does not imply that only one population exists in that area (Donovan 1991). In the "remainder" area, minke whales are relatively common in the Bering and Chukchi seas and in the Gulf of Alaska, but are not considered abundant in any other part of the eastern Pacific (Leatherwood et al. 1982; Brueggeman et al. 1990). In the Pacific, minke whales are usually seen over continental shelves (Brueggeman et al. 1990). In the extreme north, minke whales are believed to be migratory, but in inland waters of Washington and in central California they appear to establish home ranges (Dorsey et al. 1990). Minke whales occur year-round in California (Dohl et al. 1983; Forney et al. 1995; Barlow 1997) and in the Gulf of California (Tershy et al. 1990). Minke whales are present at least in summer/fall along the Baja California peninsula (Wade and Gerrodette 1993). Because the "resident" minke whales from California to Washington appear behaviorally distinct from migratory whales further north, minke whales in coastal waters of California, Oregon, and Washington (including Puget Sound) will be considered as a separate stock. Minke whales in Alaskan waters are considered in a separate stock assessment report.

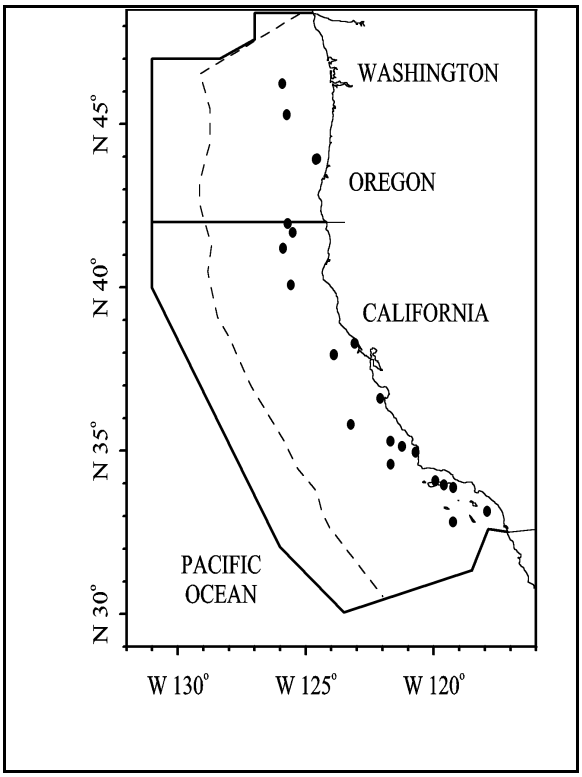

Figure 2. Minke whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1991-96 (see Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

POPULATION SIZE

No estimates have been made for the number of minke whales in the entire North Pacific. The number of minke whales is estimated as 631 (CV = 0.45) based on ship surveys in 1991, 1993, and 1996 off California and in 1996 off Oregon and Washington (Barlow 1997). Forney et al. (1995) estimate at total of 73 (CV=0.62) in California based on an aerial survey, but this estimate is negatively biased because it excludes diving whales. In addition, Green et al. (1992) report 4 sightings of minke whales in aerial surveys of Oregon and Washington, but they did not estimate population size for that area. Two minke whales were seen during 1996 aerial surveys in Washington and British Columbia inland waters (Calambokidis et al. 1997), but no abundance estimates are available for this area.

Minimum Population Estimate

The minimum population estimate for minke whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from the summer/fall ship survey in California, Oregon, and Washington waters (Barlow 1997) or approximately 440. 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

There are no data on trends in minke whale abundance in waters of California, Oregon and/or Washington.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of minke whale populations in the North Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (440) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a stock of unknown status), resulting in a PBR of 4.4.

HUMAN CAUSED MORTALITY

Historic Whaling

The estimated take of western North Pacific minke whales by commercial whalers was approximately 31,000 from 1930 to 1987 (C. Allison, IWC, pers. comm.). Minke whales were not harvested commercially in the eastern North Pacific: none were reported taken by shore-based whaling stations in central or northern California between 1919 and 1926 (Clapham et al. 1997) or between 1958 and 1965 (Rice 1974). Reported aboriginal takes of minke whales in Alaska totaled 7 between 1930 and 1987 (C. Allison, IWC, pers. comm.).

Table 1. Summary of available information on the incidental mortality and injury of minke whales (CA/OR/WA stock) for commercial fisheries that might take this species (Pierce et al. 1996; Julian 1997, Julian and Beeson 1998; Cameron and Forney 1999). Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1994 1995 1996 1997 1998	observer data	17.9% 15.6% 12.4% 23.0% 20.0%	1 0 1 0 0	6 (0.91) 0 12 (0.96) 0 0	0[1]
WA Puget Sound Region salmon drift gillnet fishery (areas 7 and 7A)	1994	observer data	7%	0	0	0
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	1991-94	observer data	10-18%	0,0,0,0	0,0,0,0	n/a
Total annual takes						0.0

[1] Only 1997-98 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).

Fishery Information

Minke whales may occasionally be caught in coastal set gillnets off California, in salmon drift gillnet in Puget Sound, Washington, and in offshore drift gillnets off California and Oregon. A summary of known fishery mortality and injury for this stock of minke whales is given in Table 1. Detailed information on this fishery is provided in Appendix 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). 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 1997-98 data. This results in an average estimate of zero minke whales taken annually. Total fishery mortality for minke whales was not estimated for the 1980-86 California Department of Fish and Game observer program for the drift gillnet fishery, but based on the 2 observed deaths in 1% of the total sets, the total mortality during this time may have been on the order of 200

minke whales or 40 per year.

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

Ship strikes were implicated in the death of one minke whale in 1977 (J. Heyning and J. Cordaro, pers. comm.). The reported minke whale mortality due to ship strikes is zero for the period 1994-98. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma.

STATUS OF STOCK

There were no known commercial whaling harvests of minke whales from Baja California to Washington. Minke whales are not listed as "endangered" under the Endangered Species Act and are not considered "depleted" under the MMPA. The greatest uncertainty in their status is whether entanglement in commercial gillnets and ship strikes could have reduced this relatively small population. Because of this, the status of the west-coast stock should be considered "unknown". The annual mortality due to fisheries (0.0/yr) and ship strikes (0.0/yr) is less than the calculated PBR for this stock (4.4), so they are not considered a "strategic" stock under the MMPA. Fishery mortality is less than 10% of the PBR; therefore, total fishery mortality is approaching zero mortality and serious injury rate. There is no information on trends in the abundance of this stock. The increasing levels of anthropogenic noise in the world's oceans has been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound.

REFERENCES

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. Admin. Rep. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25 pp.

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. 223 pp.

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.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Brueggeman, J. J., G. A. Green, K. C. Balcomb, C. E. Bowlby, R. A. Grotefendt, K. T. Briggs, M. L. Bonnell, R. G. Ford, D. H. Varoujean, D. Heinemann, and D. G. Chapman. 1990. Oregon-Washington Marine Mammal and Seabird Survey: Information synthesis and hypothesis formulation. U.S. Department of the Interior, OCS Study MMS 89-0030.

Calambokidis, J., S. Osmek, and J. L. Laake. 1997. Aerial surveys for marine mammals in Washington and British Columbia inside waters. Final Contract Report to National Marine Mammal Laboratory, Seattle, WA.

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.

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.

Dorsey, E. M., S. J. Stern, A. R. Hoelzel, and J. Jacobsen. 1990. Minke whale (Balaenoptera acutorostrata) from the west coast of North America: individual recognition and small-scale site fidelity. Rept. Int. Whal. Commn., Special Issue 12:357-368.

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.

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. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 55 pp.

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. 95 pp.

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. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

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 p.

Julian, F. 1997. Cetacean mortality in the California gill net fisheries: preliminary estimates for 1996. Paper SC/49/SM2 presented to the International Whaling Commission, September 1997 (unpublished). 13 pp.

Julian, F. and M. Beeson. 1998. Estimates for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fish. Bull. 96:271-284.

Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. NOAA Technical Rept. NMFS Circular 444. 245pp.

Pierce, D. J., M. Alexandersdottie, S. J. Jeffries, P. Erstad, W. Beattie, and A. Chapman. 1996. Interactions of marbled murrelets and marine mammals with the 1994 Puget Sound sockeye gill net fishery. Final Report, Wash. Dept. Fish and Wildlife, Olympia, WA. 21pp.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

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.

Tershy, B. R., D. Breese, and C. S. Strong. 1990. Abundance, seasonal distribution and population composition of balaenopterid whales in the Canal de Ballenas, Gulf of California, Mexico. Rept. Int. Whal. Commn., Special Issue 12:369-375.

Von Saunder, A. and J. Barlow. 1999. A report of the Oregon, California and Washington Line-transect Experiment (ORCAWALE) conducted in west coast waters during summer/fall 1996. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-264. 40 pp.

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.

Revised 12/15/2000

ROUGH-TOOTHED DOLPHIN (*Steno bredanensis*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Rough-toothed dolphins are found throughout the world in tropical and warm-temperate waters (Miyazaki and Perrin 1994). They are present around all the main Hawaiian islands (Shallenberger 1981; Tomich 1986) and have been observed at least as far northwest as French Frigate Shoals (Nitta and Henderson 1993). Recent sighting locations around the main Hawaiian Islands are shown in Figure 1. Five strandings have been reported from Maui, Oahu, and the island of Hawaii (Nitta 1991). Nothing is known about stock structure for this species in the North Pacific. For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands.

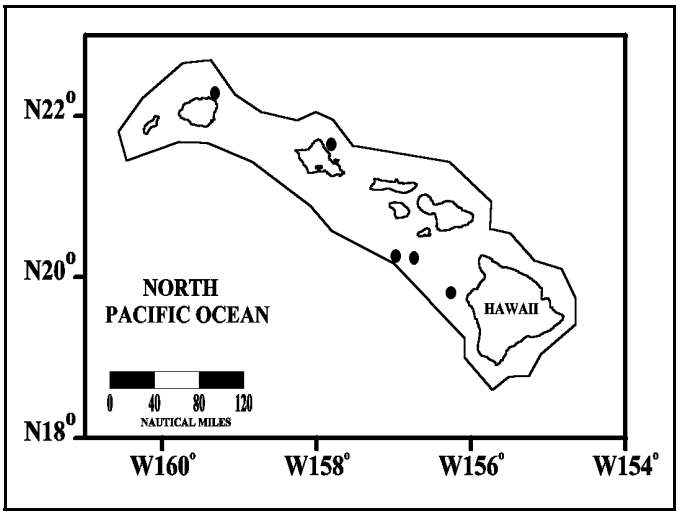

Figure 1. Rough-toothed dolphin sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

A population estimate for this species has been made in the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether these animals are part of the same population that occurs around 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 abundance estimate of 123 (CV=0.63) rough-toothed dolphins was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of rough-toothed dolphins within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 76 rough-toothed dolphins. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (76) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 0.8 rough-toothed dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available, as no mortality of this species has been documented in Hawaiian fisheries (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries, and some of these interactions involved rough-toothed dolphins (Nitta and Henderson 1993). None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999). They are known to take bait and catch from Hawaiian sport and commercial fisheries operating near the main islands and in a portion of the northwestern islands (Shallenberger 1981; Schlais 1984; Nitta and Henderson 1993), and they have been specifically reported to interact with the day handline fishery for tuna (palu-ahi) and the troll fishery for billfish and tuna (Schlais 1984; Nitta and Henderson 1993). Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins.

Other Removals

At least 22 rough-toothed dolphins were live-captured in Hawaiian waters between 1963 and 1976 (Shallenberger 1981).

STATUS OF STOCK

The status of rough-toothed dolphins in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor as “depleted” under the MMPA. Although information on rough-toothed dolphins in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality. However, there is no systematic monitoring of gillnet fisheries that may take this species, and the potential effects of interactions with the bottomfish fishery in the NWHI are not known. Insufficient information is available to determine whether the total fishery mortality and serious injury for rough-toothed dolphins is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Miyazaki, N. and W. F. Perrin. 1994. Rough-toothed dolphin *Steno bredanensis* (Lesson, 1828). *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol.5: The First Book of Dolphins, pp. 1-21. Academic Press, 416 pp.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Schlais, J.F. 1984. Thieving dolphins: A growing problem in Hawaii's fisheries. Sea Front. 30(5):293-298.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Tomich, P. Q. 1986. Mammals in Hawaii: A Synopsis and Notational Bibliography. Bishop Museum Press, Hawaii, 375 pp.

Wade, P. R. and R. P. 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.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 12/15/2000

RISSO'S DOLPHIN (*Grampus griseus*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Risso's dolphins are found in tropical to warm-temperate waters worldwide (Kruse et al. 1999). They appear to be rare in Hawaiian waters (Figure 1). Of three reported sightings of this species by Shallenberger (1981), only one was verified. There are four stranding records from the main islands (Nitta 1991). Balcomb (1987) referred to a sighting of a large herd off the Kona Coast in February 1985. For the Marine Mammal Protection Act (MMPA) stock assessment reports, Risso's dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) Hawaiian waters (this report), and 2) waters off California, Oregon and Washington.

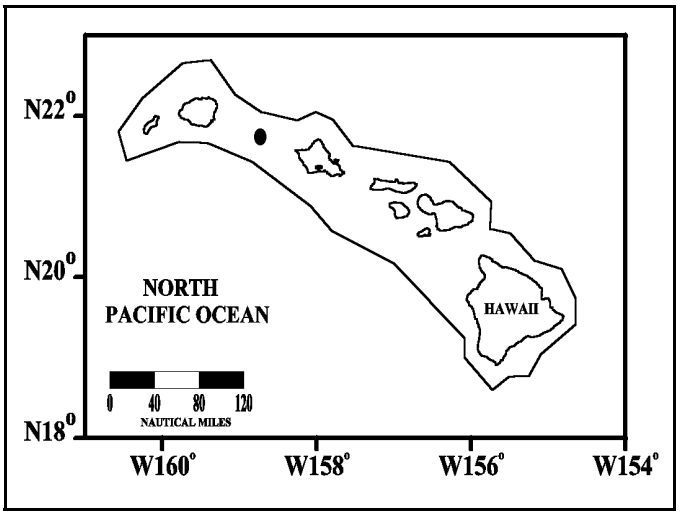

Figure 1. Sighting location for the single Risso's dolphin seen during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Population estimates have been made off Japan (Miyashita 1993) and in the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether these animals are part of the same population that occurs around 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 (Mobley et al. 2000). Only one sighting of a single Risso's dolphin was made, and therefore no meaningful abundance estimate could be calculated. Based on the locations of interactions with the Hawaiian longline fishery (Figure 2), it is likely that Risso's dolphins primarily occur in pelagic waters tens to hundreds of miles from the main Hawaiian islands and are only occasionally found nearshore.

Minimum Population Estimate

No data are available for a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

No PBR can be calculated for this species at this time.

HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of Risso's dolphins in Hawaiian waters. However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), and some of these interactions involved Risso's dolphins in waters outside the U.S. EEZ. Four Risso's dolphins were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed. This interaction rate extrapolates to a total 5-year estimate of 90 (95% CI = 27-213) Risso's dolphins, or an average of 18 per year (Kleiber 1999). Three of the observed Risso's dolphins were reported to have been hooked in the mouth or to have ingested the hook, and they were released with hook and line still attached. Following the guidelines of a 1997 Serious Injury Workshop (Angliss and DeMaster 1998), these three animals have been considered seriously injured (defined under the MMPA as likely to result in mortality). The fourth animal was hooked in an unknown location and swam normally, but was released with 20m of trailing line and a light stick. Because a substantial length of line was still attached when the animal was released, this animal is likely to have sustained serious injury. Reports for other odontocetes indicate they may also become hooked in other parts of their body, and that they may occasionally become entangled in the fishing line.

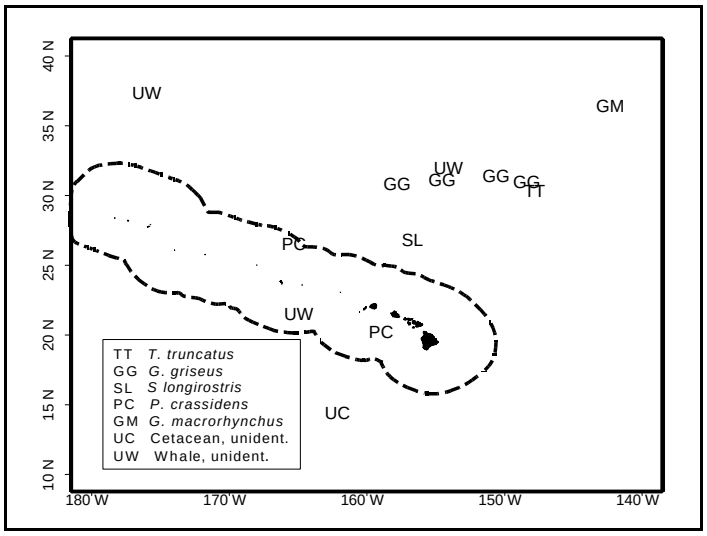

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); GG = Risso's dolphin.

Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether Risso's dolphins are involved.

STATUS OF STOCK

The status of Risso's dolphins in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on Risso's dolphins in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality within the U.S. EEZ and the species' apparent offshore distribution. The potential effect of injuries sustained by Risso's dolphins in the Hawaiian longline fishery in international waters is not known. Insufficient information is available to determine whether the total fishery mortality and serious injury for Risso's dolphins is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop 1-2 April 1997, Silver Spring, Maryland. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13. 48 pp.

Balcomb, K. C., III. 1987. The Whales of Hawaii. Marine Mammal Fund, 99 pp.

Kruse, S. K., D. K. Caldwell, and M. C. Caldwell. 1999. Risso's dolphin *Grampus griseus*. Pages 183-212 *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Volume 6. Academic Press, San Diego.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep. Int. Whal. Commn. 43:417-437.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 12/15/2000

BOTTLENOSE DOLPHIN (*Tursiops truncatus*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bottlenose dolphins are widely distributed throughout the world in tropical and warm-temperate waters. The species is primarily coastal in much of its range, but there are populations in some offshore deepwater areas as well. Separate offshore and coastal forms have been identified along continental coasts in several areas (Ross and Cockcroft 1990; Van Waerebeek et al. 1990), and similar onshore-offshore forms may exist in Hawaiian waters.

Although only three strandings have been reported (Nitta 1991), bottlenose dolphins are common throughout the Hawaiian Islands, from the island of Hawaii to Kure Atoll (Shallenberger 1981). Recent sighting locations for systematic aerial surveys within about 25nmi of the main Hawaiian Islands in 1993-98 are shown in Figure 1. In the Northwestern Hawaiian Islands, they are found primarily in relatively shallow inshore waters (Rice 1960). In the main Hawaiian Islands, they are found in both shallow inshore waters and deep channels between islands.

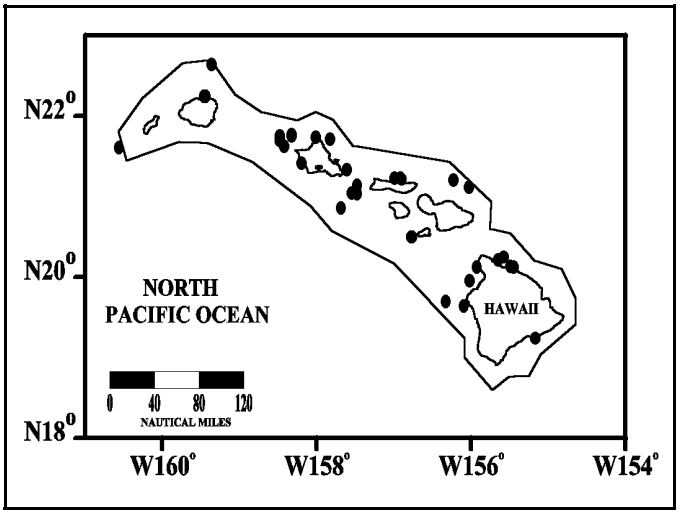

Figure 1. Bottlenose dolphin sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

In their analysis of sightings of bottlenose dolphins in the eastern tropical Pacific (ETP), Scott and Chivers (1990) noted that there was a large hiatus between the westernmost sightings and the Hawaiian Islands. These data suggest that the bottlenose dolphins in Hawaiian waters belong to a separate stock from those in the ETP. For the Marine Mammal Protection Act (MMPA) stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into three stocks: 1) Hawaiian stock (this report), 2) California, Oregon and Washington offshore stock, and 3) California coastal stock.

POPULATION SIZE

Population estimates have been made in Japanese waters (Miyashita 1993) and the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether these animals are part of the same population that occurs around 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 abundance estimate of 743 (CV=0.56) bottlenose dolphins was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of bottlenose dolphins within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 479 bottlenose dolphins. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (479) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality; Wade and Angliss 1997), resulting in a PBR of 4.8 bottlenose dolphins per year.

HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Although some mortality of bottlenose dolphins has been observed in inshore gillnets, no estimate of annual human-caused mortality and serious injury is available. The gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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).

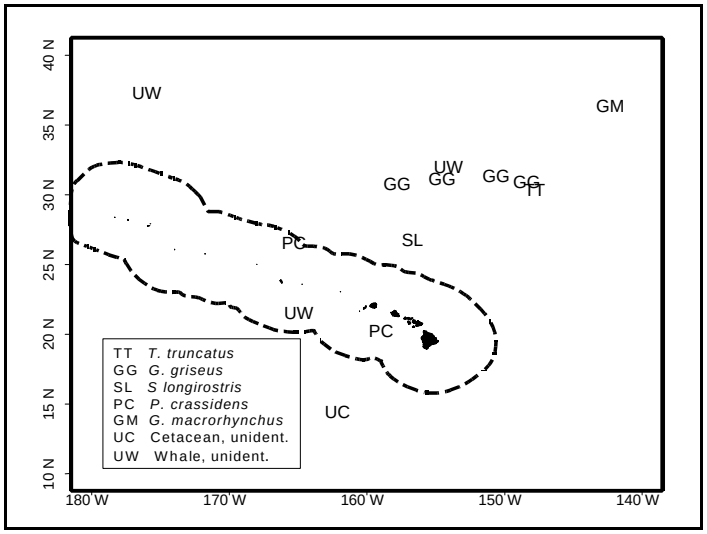

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); TT = bottlenose dolphin.

Interactions with cetaceans have been reported for all Hawaiian pelagic fisheries, and many of these interactions involved bottlenose dolphins (Nitta and Henderson 1993). One bottlenose dolphin was observed hooked in the Hawaiian longline fishery between 1994 and 1998 in waters outside the U.S. EEZ (Figure 2), with approximately 4.4% of all effort (measured as the number of hooks fished) observed. This interaction rate extrapolates to a total 5-year estimate of 23 (95% CI = 1-108) bottlenose dolphins, or an average of 4.6 interactions per year (Kleiber 1999). The single observed bottlenose dolphin was reported to have ingested the hook. Following the guidelines of a 1997 Serious Injury Workshop (Angliss and DeMaster 1998), this animal has been considered seriously injured (defined under the MMPA as likely to result in mortality). Reports for other odontocetes indicate they may also become hooked in the mouth or other part of their body, and that they may occasionally become entangled in the fishing line.

Bottlenose dolphins are one of the species commonly reported to take bait and catch from several Hawaiian sport and commercial fisheries (Nitta and Henderson 1993; Schlais 1984). Observations of bottlenose dolphins taking bait or catch have also been made in the day handline fishery (palu-ahi) for tuna, the handline fishery for mackerel scad, the troll fishery for billfish and tuna, and the inshore set gillnet fishery (Nitta and Henderson 1993). Nitta and Henderson (1993) indicated that bottlenose dolphins remove bait and catch from handlines used to catch bottomfish off the island of Hawaii and Kaula Island and on several banks of the Northwestern Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing. Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). It is not known whether these interactions result in serious injury or mortality of dolphins. Beginning in the early 1970s the National Marine Fisheries Service received reports of fishermen shooting at bottlenose dolphins to deter them from taking fish catches (Nitta and Henderson 1993). Nitta and Henderson (1993) also reported that one bottlenose dolphin calf was removed from small-mesh set gillnet off Maui in 1991 and expressed surprise that bottlenose dolphins are "rarely reported entangled or raiding set gill nets in Hawaii," considering

that they so often remove fish from fishing lines.

Other Removals

At least 36 bottlenose dolphins were live-captured in Hawaiian waters between 1963 and 1981 (Shallenberger 1981). The main capture area was around Oahu. One juvenile bottlenose dolphin was entangled in a mooring line and stranded dead along the coast of Maui in 1998 (H. Bernard, pers. comm.).

STATUS OF STOCK

The status of bottlenose dolphins in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on bottlenose dolphins in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality within the U.S. EEZ. However, there is no systematic monitoring of gillnet fisheries that may take this species, and the potential effects of interactions with the Hawaiian longline fishery in international waters or the bottomfish fishery in the NWHI are not known. Insufficient information is available to determine whether the total fishery mortality and serious injury for bottlenose dolphins is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Bernard, H. Hawai'i Wildlife Fund, P.O. Box 637, Paia, HI 96779.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep. Int. Whal. Commn. 43:417-437.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Rice, D. W. 1960. Distribution of the bottle-nosed dolphin in the leeward Hawaiian Islands. J. Mamm. 41:407-408.

Ross, G.J.B. and V. G. Cockcroft. 1990. Comments on Australian bottlenose dolphins and the taxonomic status of *Tursiops aduncus* (Ehrenberg, 1832). *In*: The Bottlenose Dolphin (eds. S. Leatherwood and R. Reeves). pp. 101-128. Academic Press, 653pp.

Schlais, J.F. 1984. Thieving dolphins: A growing problem in Hawaii's fisheries. Sea Front. 30(5):293-298.

Scott, M. D. and S. J. Chivers. 1990. Distribution and herd structure of bottlenose dolphins in the eastern tropical Pacific Ocean. *In*: The Bottlenose Dolphin (eds. S. Leatherwood and R. Reeves). pp. 387-402. Academic Press, 653pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Van Waerebeek, K., J. C. Reyes, A. J. Read, and J. S. McKinnon. 1990. Preliminary observations of bottlenose dolphins from the Pacific coast of South America. *In*: The Bottlenose Dolphin (eds. S. Leatherwood and R. Reeves). pp. 143-154. Academic Press, 653 pp.

Wade, P. R. and R. P. 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.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

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PANTROPICAL SPOTTED DOLPHIN (*Stenella attenuata*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Pantropical spotted dolphins are primarily found in tropical and subtropical waters worldwide (Perrin and Hohn 1994). Much of what is known about the species in the North Pacific has been learned from specimens obtained in the large directed fishery in Japan and in the eastern tropical Pacific (ETP) tuna purse-seine fishery (Perrin and Hohn 1994). These dolphins are common and abundant throughout the Hawaiian archipelago, particularly in channels between islands, over offshore banks (e.g. Penguin Banks), and off the lee shores of the islands (see Shallenberger 1981). Recent sighting locations around the main Hawaiian Islands are shown in Figure 1. Nitta (1991) only documented three strandings of this species in Hawaii. Morphological differences and distribution patterns have been used to establish that the spotted dolphins around Hawaii belong to a stock that is distinct from those in the ETP (Perrin 1975; Dizon et al. 1994; Perrin et al. 1994b). Their possible affinities with other stocks elsewhere in the Pacific have not been investigated. For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands. Spotted dolphins involved in eastern tropical Pacific tuna purse-seine fisheries are managed separately under the MMPA.

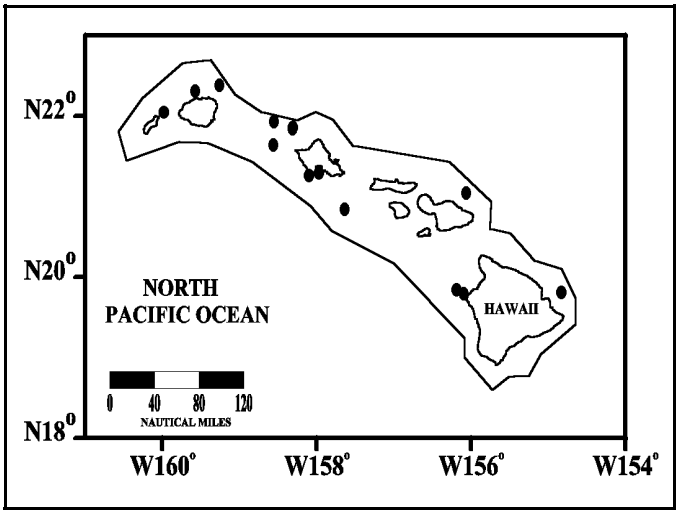

Figure 1. Pantropical spotted dolphin sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Population estimates are available for Japanese waters (Miyashita 1993) and the eastern tropical Pacific (Wade and Gerrodette 1993). 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 abundance estimate of 2,928 (CV=0.45) pantropical spotted dolphins was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of pantropical spotted dolphins within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 2,040 pantropical spotted dolphins. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (2,040) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 20 pantropical spotted dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of pantropical spotted dolphins in Hawaiian waters (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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. 1994a).

Interactions with cetaceans have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but no interactions with pantropical spotted dolphins have been documented. None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999). Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether pantropical spotted dolphins are involved.

Other Removals

At least 52 pantropical spotted dolphins were live-captured in Hawaii between 1963 and 1978 (Shallenberger 1981).

STATUS OF STOCK

The status of pantropical spotted dolphins in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor as “depleted” under the MMPA. There has been no documented human-caused mortality of this stock, and therefore they are not classified as a "strategic" stock under the MMPA. Insufficient information is available to determine whether the total fishery mortality and serious injury for pantropical spotted dolphins is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Dizon, A. E., W. F. Perrin, and P. A. Akin. 1994. Stocks of dolphins *(Stenella* spp. and *Delphinus delphis*) in the eastern tropical Pacific: a phylogeographic classification. NOAA Tech. Rep. NMFS 119, 20 pp.

Kleiber, P. 1999. Estimates of marine marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep. Int. Whal. Commn. 43:417-437.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell

(eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.
Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.
Perrin, W. F. 1975. Variation of spotted and spinner porpoise (genus *Stenella*) in the eastern tropical Pacific and Hawaii. Bull. Scripps Inst. Oceanogr. 21, 206 pp.
Perrin, W. F. and A. A. Hohn. 1994. Pantropical spotted dolphin *Stenella attenuata*. *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol.5: The First Book of Dolphins, pp 71-98. Academic Press, 416 pp.
Perrin, W.F., G. P. Donovan and J. Barlow. 1994a. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.
Perrin, W. F., G. D. Schnell, D. J. Hough, J. W. Gilpatrick, Jr., and J. V. Kashiwada. 1994b. Re-examination of geographical variation in cranial morphology of the pantropical spotted dolphin, *Stenella attenuata,* in the eastern Pacific. Fish. Bull. 92:324-346.
Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.
Wade, P. R. and R. P. 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.
Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

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SPINNER DOLPHIN (*Stenella longirostris*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Spinner dolphins are found throughout the world in tropical and warm-temperate waters (Perrin and Gilpatrick 1994). They are common and abundant throughout the entire Hawaiian archipelago (Shallenberger 1981; Norris and Dohl 1980; Norris et al. 1994). Recent sighting locations around the main Hawaiian Islands (Mobley et al. 2000) are shown in Figure 1. There is some suggestion from an intensive study of spinner dolphins off the Kona Coast of Hawaii that the waters surrounding this island may have a large, relatively stable "resident" population (Norris et al. 1994).

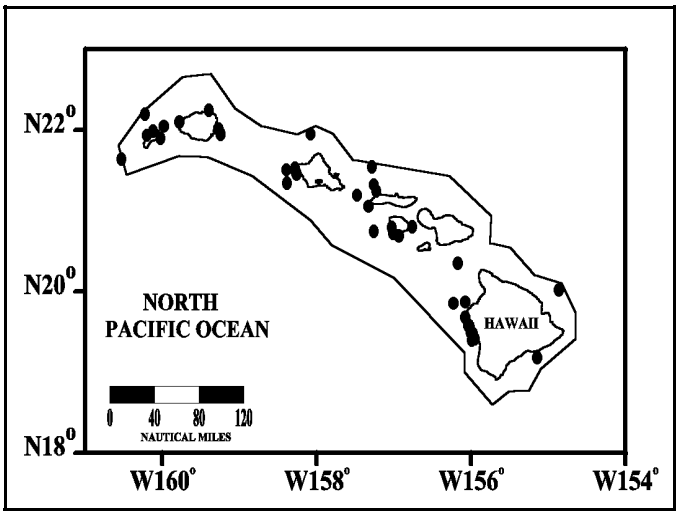

Figure 1. Spinner dolphin sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

Hawaiian spinner dolphins belong to a stock that is separate from those involved in the tuna purse-seine fishery in the eastern tropical Pacific (Perrin 1975; Dizon et al. 1994). The Hawaiian form is referable to the subspecies *S. longirostris longirostris*, which occurs pantropically (Perrin 1990). For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands. Spinner dolphins involved in eastern tropical Pacific tuna purse-seine fisheries are managed separately under the MMPA.

POPULATION SIZE

Although spinner dolphins are clearly among the most abundant cetaceans in Hawaiian waters, previously available population estimates apply only to the west coast of Hawaii. Norris et al. (1994) photoidentified 192 individuals along the west coast of Hawaii and estimated 960 animals for this area in 1979-1980. Östman (1994) photoidentified 677 individual spinner dolphins in the same area from 1989 to 1992. Using the same estimation procedures as Norris et al. (1994), Östman (1994) estimated a population size of 2,334 for his study area along the Kona coast of Hawaii. 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 abundance estimate of 3,184 (CV=0.37) spinner dolphins was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of spinner dolphins within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 2,355 spinner dolphins. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Current Population Trend

No data on current population trend are available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rate is currently available for the Hawaiian stock.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (2,355) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality; Wade and Angliss 1997), resulting in a PBR of 24 spinner dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Although some mortality of spinner dolphins has been observed in inshore gillnets, no estimate of annual human-caused mortality and serious injury is available. The gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries, and there are records of spinner dolphins taken in inshore monofilament gillnets and net fragments in Hawaiian waters (Nitta and Henderson 1993). One spinner dolphin was observed hooked in the Hawaiian longline fishery between 1994 and 1998 in waters outside the U.S. EEZ, with approximately 4.4% of all effort (measured as the number of hooks fished) observed. This interaction rate extrapolates to a total 5-year estimate of 23 (95% CI = 1-108) spinner dolphins, or an average of 4.6 interactions per year (Kleiber 1999). The single observed spinner dolphin was reported to have been hooked in the fluke. Following the guidelines of a 1997 Serious Injury Workshop (Angliss and DeMaster 1998), this animal would not be considered seriously injured (defined under the MMPA as likely to result in mortality). Reports for other odontocetes indicate they may also become hooked in the mouth or ingest the hook, and they may occasionally become entangled in the fishing line. Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether spinner dolphins are involved.

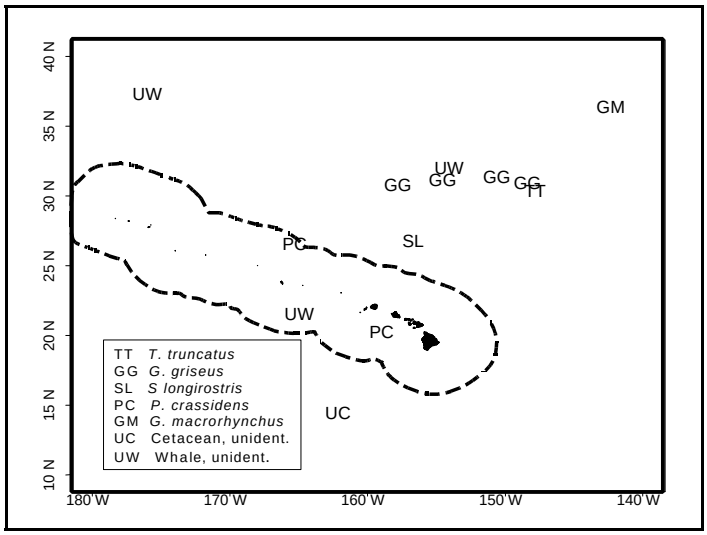

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); SL = spinner dolphin.

Other Removals

At least 85 spinner dolphins were live-captured in Hawaiian waters from 1962 to 1981 (Shallenberger 1981). The main capture area was around Oahu.

STATUS OF STOCK

The status of spinner dolphins in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. A habitat issue of increasing concern is the potential effect of swim-with-dolphin

programs and other tourism activities on spinner dolphins around the main Hawaiian Islands. Spinner dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. The Hawaiian stock is not considered a strategic stock under the 1994 amendments to the MMPA, because there are no estimates of mortality within the U.S. EEZ. However, there is no systematic monitoring of gillnet fisheries that may take this species, and the potential effect of interactions with the Hawaiian longline fishery in international waters is not known. Insufficient information is available to determine whether the total fishery mortality and serious injury for spinner dolphins is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop 1-2 April 1997, Silver Spring, Maryland. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13. 48 pp.

Dizon, A. E., W. F. Perrin, and P. A. Akin. 1994. Stocks of dolphins *(Stenella* spp. and *Delphinus delphis*) in the eastern tropical Pacific: a phylogeographic classification. NOAA Tech. Rep. NMFS 119, 20 pp.

Kleiber, P. 1999. Estimates of marine marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Norris, K. S., B. Würsig, R. S. Wells, and M. Würsig. 1994. The Hawaiian Spinner Dolphin. University of California Press, 408 pp.

Norris, K. S. and T. P. Dohl. 1980. Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. Fish. Bull. 77:821-849.

Östman, J. S. O. 1994. Social organization and social behavior of Hawaiian spinner dolphins *(Stenella longirostris)*. Ph.D. dissertation, University of California, Santa Cruz, 114 pp.

Perrin, W. F. 1975. Variation of spotted and spinner porpoise (genus *Stenella*) in the eastern tropical Pacific and Hawaii. Bull. Scripps Inst. Oceanogr. 21, 206 pp.

Perrin, W. F. 1990. Subspecies of *Stenella longirostris* (Mammalia: Cetacea: Delphinidae). Proc. Biol. Soc. Wash. 103:453-463.

Perrin, W. F. and J. W. Gilpatrick, Jr. 1994. Spinner dolphin *Stenella longirostris* (Gray, 1828). *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol.5: The First Book of Dolphins, pp. 99-128. Academic Press, 416 pp.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Wade, P. R. and R. P. 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.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

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STRIPED DOLPHIN (*Stenella coeruleoalba*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Striped dolphins are found in tropical to warm-temperate waters throughout the world (Perrin et al. 1994). There is an incongruity between the frequency of strandings and the infrequency of sightings of this species in Hawaii. Nitta (1991) found more stranding records of striped dolphins (13) than of any other species between 1936 and 1988, yet Shallenberger (1981) was aware of only two at-sea sightings, one near Niihau and one west of Oahu. A single sighting was made during recent systematic surveys within about 25 nmi of the main Hawaiian Islands (Figure 1). The Sea Life Park collecting crew never encountered striped dolphins from the early 1960s through the late 1970s, during their live-capture operations (Shallenberger 1981).

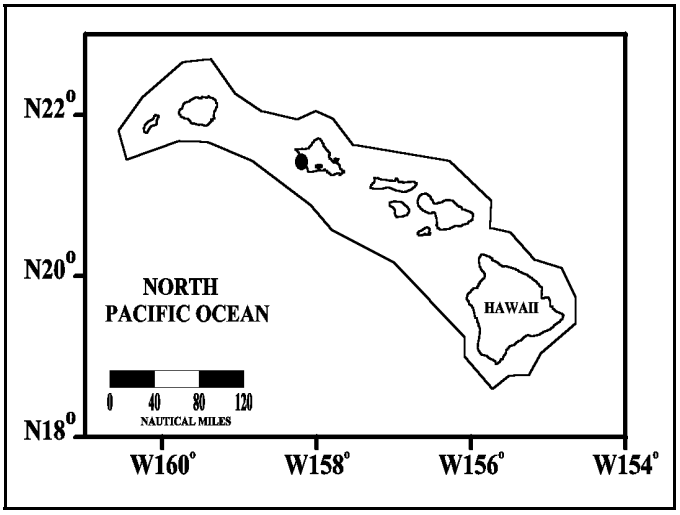

Figure 1. Location of the single sighting of striped dolphins during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

Striped dolphins have been intensively exploited in the western North Pacific, where three migratory stocks are provisionally recognized (Kishiro and Kasuya 1993). In the eastern Pacific all striped dolphins are provisionally considered to belong to a single stock (Dizon et al. 1994). For the Marine Mammal Protection Act (MMPA) stock assessment reports, striped dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington, and 2) waters around Hawaii (this report). Striped dolphins involved in eastern tropical Pacific tuna purse-seine fisheries are managed separately under the MMPA.

POPULATION SIZE

Population estimates are available for Japanese waters (Miyashita 1993) and the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether any of these animals are part of the same population that occurs around 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 abundance estimate of 114 (CV=1.19) striped dolphins was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of striped dolphins within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed.

Minimum Population Estimate

No data are available for a minimum population estimate. The log-normal 20th percentile of the combined 1993-98 abundance estimate is 52 striped dolphins. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (52) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 0.5 striped dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of striped dolphins in Hawaiian waters (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but no interactions with striped dolphins have been documented. None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999). Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether striped dolphins are involved.

STATUS OF STOCK

The status of striped dolphins in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on striped dolphins in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality. Insufficient information is available to determine whether the total fishery mortality and serious injury for striped dolphins is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Dizon, A. E., W. F. Perrin, and P. A. Akin. 1994. Stocks of dolphins *(Stenella* spp. and *Delphinus delphis*) in the eastern tropical Pacific: a phylogeographic classification. NOAA Tech. Rep. NMFS 119, 20 pp.

Kishiro, T. and T. Kasuya. 1993. Review of Japanese dolphin drive fisheries and their status. Rep. Int. Whal. Commn. 43:439-452.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep. Int. Whal. Commn. 43:417-437.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W. F., C. E. Wilson, and F. I. Archer, II. 1994. Striped dolphin *Stenella coeruleoalba* (Meyen, 1833). *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol.5: The First Book of Dolphins, pp 129-159. Academic Press, 416 pp.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Wade, P. R. and R. P. 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.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

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MELON-HEADED WHALE (*Peponocephala electra*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Melon-headed whales are found in tropical and warm-temperate waters throughout the world. The distribution of reported sightings suggests that the oceanic habitat of this species is primarily equatorial waters (Perryman et al. 1994). Small numbers have been taken in the eastern tropical Pacific, and they are occasionally killed in direct fisheries in Japan and elsewhere in the western Pacific. Large herds are seen regularly in Hawaiian waters, especially off the Waianae coast of Oahu, the north Kohala coast of Hawaii, and the leeward coast of Lanai (Shallenberger 1981). Recent sighting locations around the main Hawaiian Islands (Mobley et al. 2000) are shown in Figure 1. Little is known about this species elsewhere in its range, and most knowledge about its biology comes from mass strandings (Perryman et al. 1994). Ten strandings are known from Hawaii (Nishiwaki and Norris 1966; Shallenberger 1981; Nitta 1991). For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands.

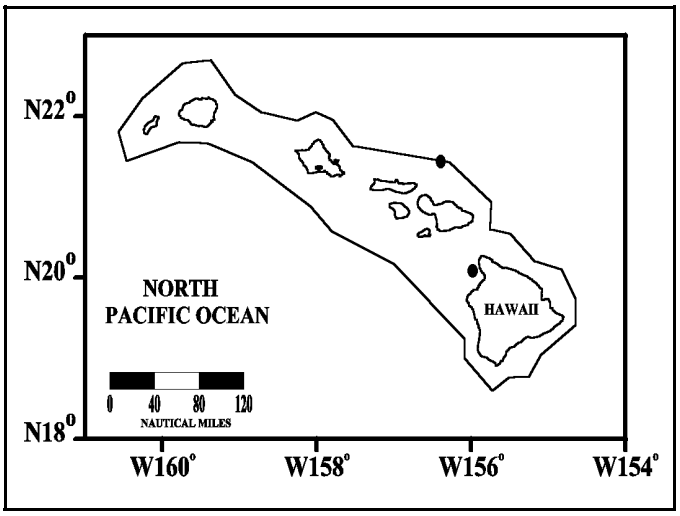

Figure 1. Melon-headed whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

An estimate of melon-headed whales is available for the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether any of these animals are part of the same population that occurs around 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 abundance estimate of 154 (CV=0.88) melon-headed whales was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of melon-headed whales within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 81 melon-headed whales. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Minimum Population Estimate

No data are available for making a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (81) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 0.8 melon-headed whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Melon-headed whales are not known to be taken directly or incidentally in Hawaiian waters and no mortality of this species has been documented in Hawaiian fisheries (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but no interactions with melon-headed whales have been documented. None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999). Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether melon-headed whales are involved.

Historical Mortality

Peale (1848) reported that 60 whales of this species were driven ashore by natives in Hilo Bay, Hawaii in 1841. At least three melon-headed whales were live-captured for public display between 1966 and 1978 (Shallenberger 1981).

STATUS OF STOCK

The status of melon-headed whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor as “depleted” under the MMPA. Although information on melon-headed whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality. Insufficient information is available to determine whether the total fishery mortality and serious injury for melon-headed whales is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nishiwaki, M. and K. S. Norris. 1966. A new genus, *Peponocephala*, for the odontocete cetacean species *Electra electra*. Sci. Rep. Whales Res. Inst. 20:95-100.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar.

Fish. Rev. 55(2):83-92.
Peale, T. R. 1848. United States Exploring Expedition. During the Years 1838, 1839, 1840, 1841, 1842. Under the Command of Charles Wilkes, U.S.N. Vol. VIII. Mammalia and Ornithology. C Sherman, Philadelphia, 338 pp.
Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.
Perryman, W. L., D. W. K. Au, S. Leatherwood, and T. A. Jefferson. 1994. Melon-headed whale *Peponocephala electra* Gray, 1846. *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol.5: The First Book of Dolphins, pp. 363-386. Academic Press, 416 pp.
Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.
Wade, P. R. and R. P. 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.
Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 12/15/2000

PYGMY KILLER WHALE (*Feresa attenuata*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Pygmy killer whales are found in tropical and subtropical waters throughout the world (Ross and Leatherwood 1994). They are poorly known in most parts of their range. Small numbers have been taken directly and incidentally in both the western and eastern Pacific. Most knowledge of this species is from stranded or live-captured specimens. Pryor et al. (1965) stated that pygmy killer whales have been observed several times off the lee shore of Oahu, and that "they seem to be regular residents of the Hawaiian area." Although all sightings up to that time had been off Oahu and the Big Island, Shallenberger (1981) stated that this species might be found elsewhere in Hawaii, as well. No pygmy killer whales were seen during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (Mobley et al. 2000; see Appendix 2 for detailed information on timing and location of effort), suggesting that they are uncommon in these nearshore regions. Nitta (1991) documented five strandings from Maui and the island of Hawaii. For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands.

POPULATION SIZE

A population estimate has been made for this species in the eastern tropical Pacific (Wade and Gerrodette 1993), but no data are available to estimate population size in any other area of the North Pacific. 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 (Mobley et al. 2000). No sightings of pygmy killer whales were made, and therefore no abundance estimate for nearshore Hawaiian waters is presently available. It is likely that pygmy killer whales occur primarily in pelagic waters greater than 25 nmi from the main Hawaiian islands.

Minimum Population Estimate

No data are available for a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

No PBR can be calculated for this species at this time.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of pygmy killer whales in Hawaiian waters. However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but no interactions with pygmy killer whales have been documented. None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999). Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known

whether these interactions result in serious injury or mortality of dolphins, nor whether pygmy killer whales are involved.

Other Removals

Three specimens were live-captured by Sea Life Park between 1963 and 1971 (Pryor et al. 1965; Pryor 1975; Shallenberger 1981).

STATUS OF STOCK

The status of pygmy killer whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. This species is not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on pygmy killer whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality. Insufficient information is available to determine whether the total fishery mortality and serious injury for pygmy killer whales is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Pryor, K. 1975. Lads Before the Wind: Adventures in Porpoise Training. Harper and Row, New York, 278 pp.

Pryor, T., K. Pryor and K. S. Norris. 1965. Observations on a pygmy killer whale (*Feresa attenuata* Gray) from Hawaii. J. Mamm. 46:450-461.

Ross, G. J. B. and S. Leatherwood. 1994. Pygmy killer whale *Feresa attenuata* Gray, 1874. *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol.5: The First Book of Dolphins, pp.387-404. Academic Press, 416 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 10/31/2002

FALSE KILLER WHALE (*Pseudorca crassidens*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

False killer whales are found worldwide mainly in tropical and warm-temperate waters (Stacey et al. 1994). In the North Pacific, this species is well known from southern Japan, Hawaii, and the eastern tropical Pacific. It occurs around all the main Hawaiian Islands, but its presence around the Northwestern Hawaiian Islands has not yet been established (Nitta and Henderson 1993). Recent sighting locations around the main Hawaiian Islands (Mobley et al. 2000) are shown in Figure 1. There are only 4 stranding records from Hawaiian waters (Nitta 1991). Large numbers of false killer whales have been taken in direct fisheries in southern Japan, and small numbers have been taken incidental to fishing operations in the eastern tropical Pacific. Most knowledge about this species comes from outside Hawaiian waters (Stacey et al. 1994). For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands.

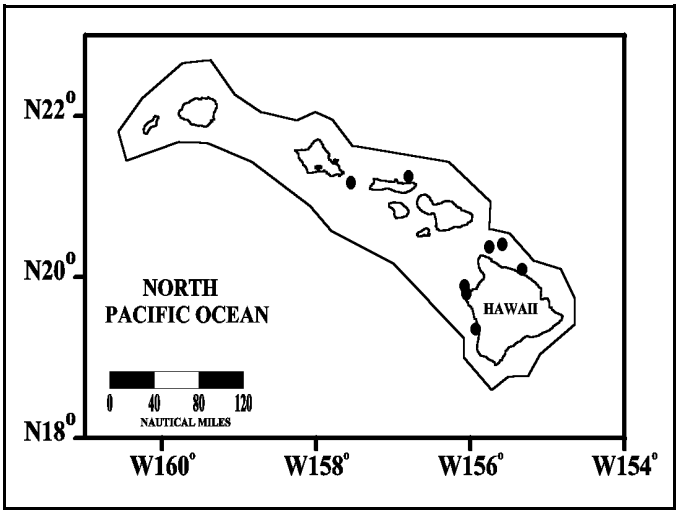

Figure 1. False killer whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Population estimates for this species have been made from shipboard surveys in Japan (Miyashita 1993) and the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether these animals are part of the same population that occurs around 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 abundance estimate of 121 (CV=0.47) false killer whales was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of false killer whales within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed and estimates are uncorrected for the proportion of diving animals missed from the survey aircraft. A line-transect vessel survey of the Hawaiian archipelago EEZ is planned for summer/autumn 2002 which will provide a more comprehensive estimate of abundance for this stock.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 83 false killer whales. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (83) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a species of unknown status; Wade and Angliss 1997), resulting in a PBR of 0.8 false killer whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Although little is known about incidental mortality of false killer whales in Hawaiian waters (Nitta and Henderson 1993), mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries, and false killer whales have been identified in fishermen's logs as taking catches from pelagic longlines (Nitta and Henderson 1993). They have also been observed feeding on mahi mahi, *Coryphaena hippurus*, and yellowfin tuna, *Thunnus albacares*, and frequently steal large fish (up to 70 pounds) (Shallenberger 1981) from the trolling lines of both commercial and recreational fishermen (S. Kaiser, pers. comm.).

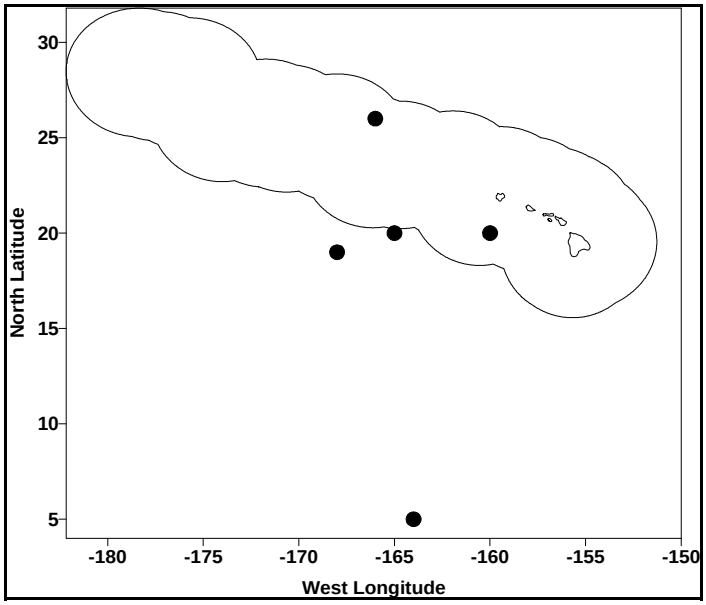

Figure 2. Locations of observed false killer whale interactions in the Hawaiian longline fishery, 1997-2001. The solid line surrounding the Hawaiian Islands represents the U.S. Exclusive Economic Zone (EEZ).

Five false killer whales were observed hooked in the Hawaiian longline fishery between 1997 and 2001 (1 each in 1997 and 1998 and 3 in 2001) (Figure 2). All three of the 2001 interactions occurred outside the U.S. EEZ. Three of the observed false killer whales were reported to have been hooked in the mouth or to have ingested the hook, and two were released with trailing gear. Reports for other odontocetes indicate they may also become hooked in other parts of their body, and that they may occasionally become entangled in the fishing line. Following the guidelines of a 1997 Serious Injury Workshop (Angliss and DeMaster 1998), the three observed false killer whales have been considered seriously injured (defined under the MMPA as likely to result in mortality). During the most recent five year period for which complete annual longline data are available (1996-2000), there were two observed false killer whale interactions within the U.S. EEZ. With approximately 5.7% annual observer coverage over these five years (2000 observer coverage exceeded 10%, all other years were approximately 4%), this interaction rate extrapolates to a total 5-year estimate of 35 (95% CI = 5-112) false killer whales, or an average of 7 interactions per year. The Hawaiian longline fishery currently operates under new restrictions which prohibit swordfish style fishing methods (deepest hooks fished at depths < 100 m, use of lightsticks, setting at night) in an effort to reduce sea turtle mortality (NMFS Western Pacific Pelagic Fisheries Biological Opinion 2001). Other sea turtle bycatch reduction methods implemented include time and area closures for tuna style fishing methods, limited access permit restrictions, gear modification research, and skipper workshops aimed at reducing sea turtle interactions. Changes in this fishery have not been in place long enough to assess their influence on the rate of cetacean interactions. From 1996-2000, the number of Hawaii-based vessels in the fishery has ranged from 104-125. The number of hooks set in the fishery has steadily increased from 1996-2000, with 14.4, 15.5, 17.3, 19.1, and 20.2 million hooks set, respectively. The corresponding number of sets for this period were 11,638, 11,846, 12,506, 12,776, and 12,930, respectively. A majority of the effort in this fishery occurs outside

the U.S. EEZ. An additional 40-50 longline vessels participate in a fishery west of California outside the U.S. EEZ and land their catch in California ports. It is unknown if this smaller fishery interacts with false killer whales.

Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether false killer whales are involved.

Other Removals

Since the early 1960's, at least 12 false killer whales have been live-captured by aquaria or the Navy (Pryor 1975; Shallenberger 1981; J. Thomas pers. comm.).

STATUS OF STOCK

The status of false killer whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Because the rate of serious injury to false killer whales within the U.S. EEZ in the Hawaiian longline fishery (7 animals per year) exceeds the PBR (0.8), this stock is considered a strategic stock under the 1994 amendments to the MMPA. The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero, because it exceeds the PBR. However, the available abundance estimate, on which PBR is based, applies only to a portion of this species' range in Hawaiian waters, and additional studies of abundance, distribution, and fishery-related mortality and injury of false killer whales in Hawaiian waters will be required to re-evaluate this species' status in the future. A line-transect vessel survey of the Hawaiian archipelago EEZ is planned for summer/autumn 2002 which will provide a more comprehensive estimate of abundance for this stock.

REFERENCES

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop 1-2 April 1997, Silver Spring, Maryland. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13. 48 pp.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep. Int. Whal. Commn. 43:417-437.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

NMFS Western Pacific Pelagic Fisheries Biological Opinion 2001.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Pryor, K. 1975. Lads Before the Wind: Adventures in Porpoise Training. Harper and Row, New York, 278 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Stacey, P. J., S. Leatherwood, and R. W. Baird. 1994. *Pseudorca crassidens*. Mamm. Spec. 456:1-6.

Wade, P. R. and R. P. 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.
Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 12/15/2000

KILLER WHALE (*Orcinus orca*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters (Heyning and Dahlheim 1988), killer whales prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). They are rare in Hawaiian waters. No killer whales were seen during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (Mobley et al. 2000; see Appendix 2 for detailed information on timing and location of effort), suggesting that they are uncommon in these nearshore regions. One stranding from the island of Hawaii was reported in 1950 (Richards 1952). Two sightings have been reported, one in January 1978 off the Waianae Coast of Oahu and another in December 1979 near Kauai (Shallenberger 1981). Except in the northeastern Pacific where "resident", "transient", and “offshore” stocks have been described for coastal waters of Alaska, British Columbia, and Washington to California (Bigg 1982; Leatherwood et al. 1990, Bigg et al. 1990, Ford et al. 1994), little is known about stock structure of killer whales in the North Pacific. For the Marine Mammal Protection Act (MMPA) stock assessment reports, five killer whale stocks are recognized within the Pacific U.S. EEZ 1) the Eastern North Pacific Northern Resident stock - occurring from British Columbia through Alaska, 2) the Eastern North Pacific Southern Resident stock - occurring within the inland waters of Washington State and southern British Columbia, 3) the Eastern North Pacific Transient stock - occurring from Alaska through California, 4) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California, and 5) the Hawaiian stock (this report). The Stock Assessment Reports for the Alaska Region contains the assessment of the Eastern North Pacific Northern Resident stock; all other killer whale stock assessments are included in this report.

POPULATION SIZE

Population sizes for killer whales in the coastal waters of British Columbia and Washington are known from photo-identification studies (Bigg et al. 1990). The population of killer whales in the eastern tropical Pacific has been estimated from shipboard sightings surveys (Wade and Gerrodette 1993). No data to estimate population size are available for the central Pacific. 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 (Mobley et al. 2000). No sightings of killer whales were made, and therefore no abundance estimate for Hawaiian waters is presently available.

Minimum Population Estimate

No data are available to provide a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current and maximum net productivity rate in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

No PBR can be calculated for this stock at this time.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available for killer whales in Hawaiian waters (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but killer whale interactions appear to be rare. In 1990, a solitary killer whale was reported to have removed the catch from a longline in Hawaii (Dollar 1991). None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999). Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether killer whales are involved.

STATUS OF STOCK

The status of killer whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. This species is not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on killer whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA given the insignificance of reported fisheries related mortality. Insufficient information is available to determine whether the total fishery mortality and serious injury for killer whales is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Bigg, M. A. 1982. An assessment of killer whale (*Orcinus orca*) stocks off Vancouver Island, British Columbia. Rep. Int. Whal. Commn. 32:655-666.

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford, and K. C. Balcomb, III. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep. Int. Whal. Commn. (Spec. Iss. 12):383-405.

Dollar, R. A. 1991. Summary of swordfish longline observations in Hawaii, July 1990-March 1991. Southwest Fish. Cent. Admin. Rep. H-91-09, 13 pp.

Ford, J. K. B., G. M. Ellis, and K.C. Balcomb. 1994. Killer whales. The natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. UBC Press, Vancouver, Canada

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Leatherwood, J. S., and M. E. Dahlheim. 1978. Worldwide distribution of pilot whales and killer whales. Naval Ocean Systems Center, Tech. Rep. 443:1-39.

Heyning, J. E. and M. E. Dahlheim. 1988. *Orcinus orca*. Mamm. Spec.304:1-9.

Leatherwood, S., C. O. Matkin, J. D. Hall, and G. M. Ellis. 1990. Killer whales, *Orcinus orca*, photo-identified in Prince William Sound, Alaska, 1976 through 1987. Can Field-Nat. 104:362-371.

Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Board Canada, 32:914-916.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-99-XXC. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Richards, L. P. 1952. Cuvier's beaked whale from Hawaii. J. Mamm. 33:255.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-

77/23, 79pp.
Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 12/15/2000

SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Short-finned pilot whales are found in all oceans, primarily in tropical and warm-temperate waters. They are commonly observed around the main Hawaiian Islands and are probably also present around the Northwestern Hawaiian Islands (Shallenberger 1981). Recent sighting locations around the main Hawaiian Islands (Mobley et al. 2000) are shown in Figure 1. Several mass strandings have been reported from the main islands (Tomich 1986; Nitta 1991). In Japanese waters, two stocks have been identified based on pigmentation patterns and differences in the shape of the heads of adult males (Kasuya et al. 1988). The pilot whales in Hawaiian waters are similar to the Japanese "southern form." Stock structure of short-finned pilot whales has not been adequately studied in the North Pacific, except in Japanese waters. Preliminary photo-identification work with pilot whales in Hawaii indicated a high degree of site fidelity around the main island of Hawaii (Shane and McSweeney 1990). For the Marine Mammal Protection Act (MMPA) stock assessment reports, short-finned pilot whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) Hawaiian waters (this report), and 2) waters off California, Oregon and Washington.

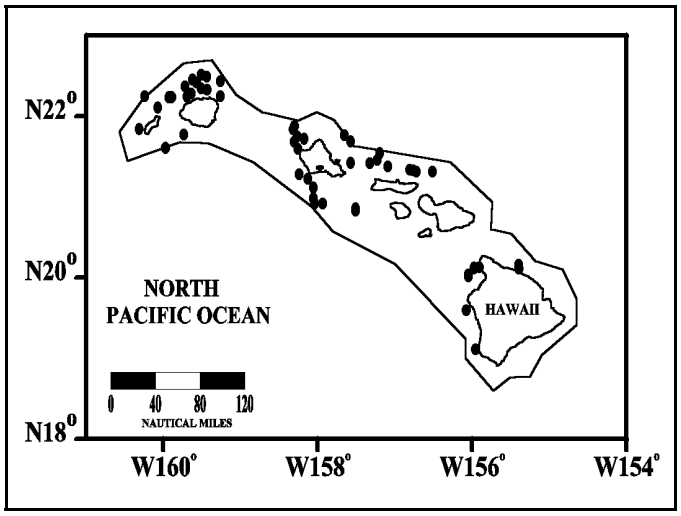

Figure 1. Short-finned pilot whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Estimates of short-finned pilot whale populations have been made off Japan (Miyashita 1993) and in the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether any of these animals are part of the same population that occurs around 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 abundance estimate of 1,708 (CV=0.32) short-finned pilot whales was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of short-finned pilot whales within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 1,313 short-finned pilot whales. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,313) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with a known fishery mortality within the U.S. EEZ off Hawaii; Wade and Angliss 1997), resulting in a PBR of 13 short-finned pilot whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Mortality of cetaceans has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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).

One short-finned pilot whale was observed killed outside the U.S. EEZ in the Hawaiian longline fishery between 1994 and 1998 (Figure 2), with approximately 4.4% of all effort (measured as the number of hooks fished) observed. This mortality rate extrapolates to a total 5-year estimate of 23 (95% CI = 1-108) short-finned pilot whales, or an average of 4.6 animals killed per year (Kleiber 1999). The single observed short-finned pilot whale was reported to have been entangled in the fishing line. Reports for other odontocetes indicate animals may also ingest the hook or become hooked in the mouth or other part of their body.

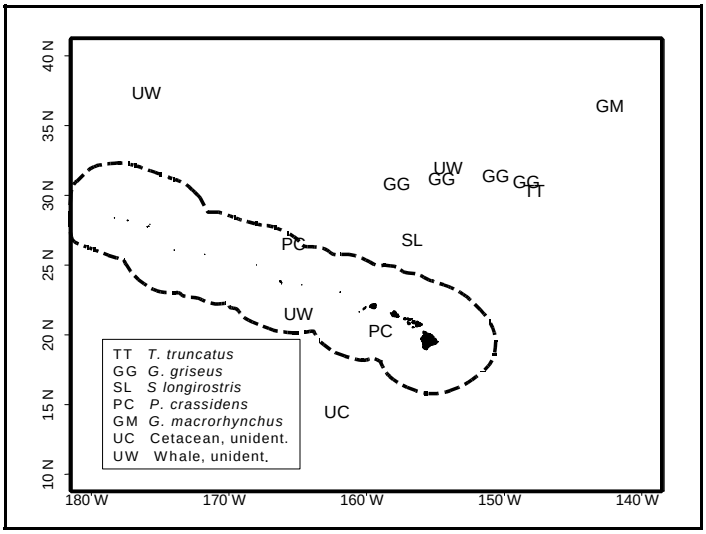

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); GM = short-finned pilot whale.

Interactions with cetaceans have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but no other interactions with short-finned pilot whales have been documented. Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether short-finned pilot whales are involved.

Other Removals

Since 1963, at least 20 short-finned pilot whales have been live-captured from Hawaiian waters by Sea Life Park/Oceanic Foundation (Shallenberger 1981).

STATUS OF STOCK

The status of short-finned pilot whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor as “depleted” under the MMPA. Although information on short-finned pilot whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality within the U.S. EEZ. However, the potential effect of mortality in the Hawaiian longline fishery in international waters

is not known. Insufficient information is available to determine whether the total fishery mortality and serious injury for short-finned pilot whales is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Kasuya, T., T. Miyashita, and F. Kasamatsu. 1988. Segregation of two forms of short-finned pilot whales off the Pacific coast of Japan. Sci. Rep. Whales Res. Inst. 39:77-90.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep. Int. Whal. Commn. 43:417-437.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Shane, S. H. and D. McSweeney. 1990. Using photo-identification to study pilot whales social organization. Rep. Int. Whal. Commn. (Spec. Iss. 12):259-263.

Tomich, P. Q. 1986. Mammals in Hawaii: A Synopsis and Notational Bibliography. Bishop Museum Press, Hawaii, 375 pp.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, WA. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 12/15/2000

BLAINVILLE'S BEAKED WHALE (*Mesoplodon densirostris*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Blainville's beaked whale has a cosmopolitan distribution in tropical and temperate waters, apparently the most extensive known distribution of any *Mesoplodon* species (Mead 1989). Two strandings were reported in 1961 from Midway Island (Galbreath 1963) and another in 1983 from Laysan Island (Nitta 1991). Sixteen sightings were reported from the main islands by Shallenberger (1981), who suggested that Blainville's beaked whales were present off the Waianae Coast of Oahu for prolonged periods annually. Balcomb (1987) speculated that this species is "more common in Hawaii than anywhere else in the world." Recent sighting locations around the main Hawaiian Islands (Mobley et al. 2000) are shown in Figure 1. Although all identified Mesoplodon records from Hawaiian waters are of *M. densirostris*, several other species in the genus *Mesoplodon* are known from the North Pacific and may be recorded in Hawaiian waters in the future (see Mead 1989). There is no information on stock structure of Blainville's beaked whale. For the Marine Mammal Protection Act (MMPA) stock assessment reports, three *Mesoplodon* stocks are defined: 1) *M. densirostris* in Hawaiian waters (this report), 2) *M. stejnegeri* in Alaskan waters, and 3) all *Mesoplodon* species off California, Oregon and Washington.

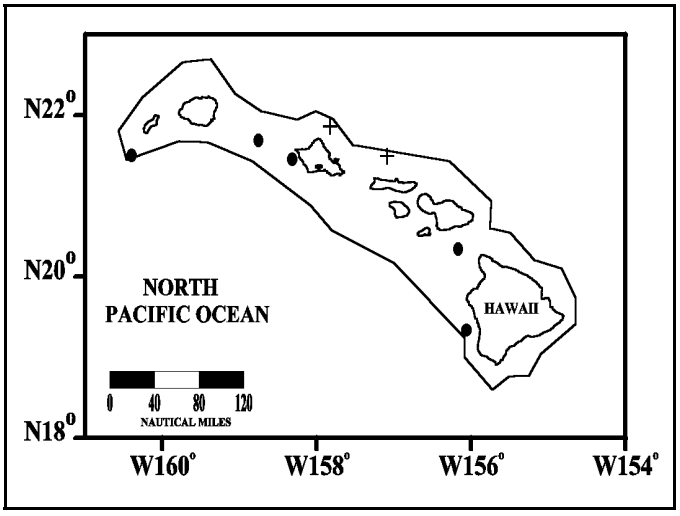

Figure 1. Blainville's beaked whale (**!**) and unidentified *Mesoplodon* (+) sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

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. Seven sightings of Blainville's beaked whales were made. An abundance estimate of 68 (CV=0.60) Blainville's beaked whales was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of Blainville's beaked whales within the U.S. EEZ off Hawaii, because areas around the Northwest 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.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 43 Blainville's beaked whales. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and does not include a large proportion of animals that were diving and therefore unavailable to be seen.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (43) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 0.4 Blainville's beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of Blainville's beaked whales in Hawaiian waters (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 dolphins are reported for all pelagic fisheries, and humpback whales have been entangled in longlines off the Hawaiian Islands (Nitta and Henderson 1993), but no takes of Blainville's beaked whales have been documented. However, three unidentified whales and one unidentified cetacean were observed hooked in the Hawaiian longline fishery between 1994 and 1998 (Figure 2), with approximately 4.4% of all effort (measured as the number of hooks fished) observed. Observer descriptions and photographs of these interactions indicate that at least two of the unidentified whales may have been beaked whales, including one within the U.S. EEZ. The total interaction rate based on these two possible beaked whales extrapolates to a 5-year estimate of 45 (95% CI = 7-108), or an average of 9 interactions per year (Kleiber 1999). One of the two possible beaked whales was hooked in the fluke, and following the guidelines of a 1997 Serious Injury Workshop (Angliss and DeMaster 1998), this would not be considered a serious injury (defined under the MMPA as likely to result in mortality). The other interaction, which took place within the U.S. EEZ, involved a possible beaked whale that was hooked but broke the line and swam away before the location of the hook could be ascertained. Therefore, no determination can be made regarding the severity of this second injury. Reports for other odontocetes indicate they may also become hooked in the mouth or ingest the hook, and that they may occasionally become entangled in the fishing line. Insufficient information is available to evaluate whether some of these unidentified whales may have been Blainville's beaked whales.

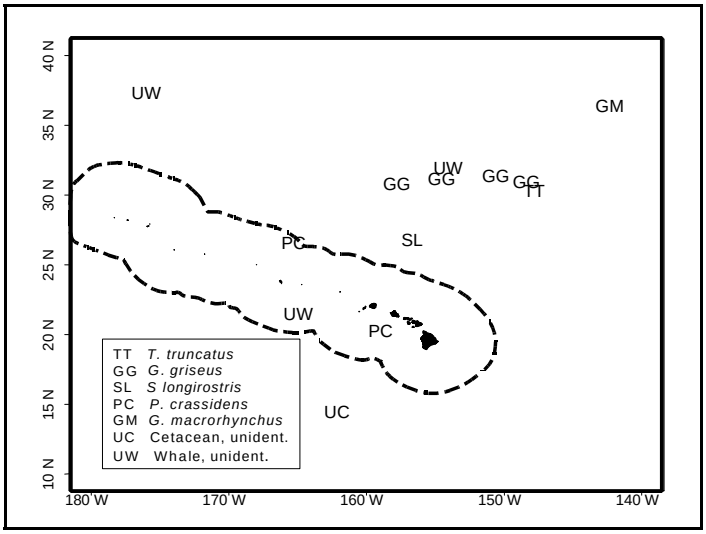

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); UW = unidentified whale; UC = unidentified cetacean. The two westernmost unidentified whales may have been Blainville's beaked whales.

STATUS OF STOCK

The status of Blainville's beaked whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on Blainville's beaked whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA because there has been no reported fisheries related mortality within the U.S. EEZ. However, the effect of potential interactions of unidentified beaked whales (which may have been Blainville's beaked whales) with the

Hawaiian longline fishery in U.S. and international waters is not known. Insufficient information is available to determine whether the total fishery mortality and serious injury for Blainville's beaked whales is insignificant and 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 Blainville's beaked whales that feed in the oceans' "sound channel".

REFERENCES

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop 1-2 April 1997, Silver Spring, Maryland. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13. 48 pp.

Balcomb, K. C., III. 1987. The Whales of Hawaii. Marine Mammal Fund, 99 pp.

Galbreath, E. C. 1963. Three beaked whales stranded on the Midway Islands, central Pacific Ocean. J. Mamm. 44:422-423.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Mead, J. G. 1989. Beaked whales of the genus *Mesoplodon. In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 4: The River Dolphins and Larger Toothed Whales, pp. 349-430. Academic Press, 442 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W. F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Shallenberger, E. W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Wade, P. R. and R. P. 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.

Revised 12/15/2000

CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Cuvier's beaked whales occur in all oceans and major seas (Heyning 1989). In Hawaii, strandings have been reported from Midway Islands, Pearl and Hermes Reef, Oahu, and Hawaii Islands (Shallenberger 1981; Galbreath 1963; Richards 1952; Nitta 1991). Sightings have been reported off Lanai and Maui (Shallenberger 1981). Recent sighting locations around the main Hawaiian Islands (Mobley et al. 2000) are shown in Figure 1. Nothing is known about stock structure for this species. For the Marine Mammal Protection Act (MMPA) stock assessment reports, Cuvier's beaked whales within the Pacific U.S. Exclusive Economic Zone are divided into three discrete, non-contiguous areas: 1) Hawaiian waters (this report), 2) Alaskan waters, and 3) waters off California, Oregon and Washington.

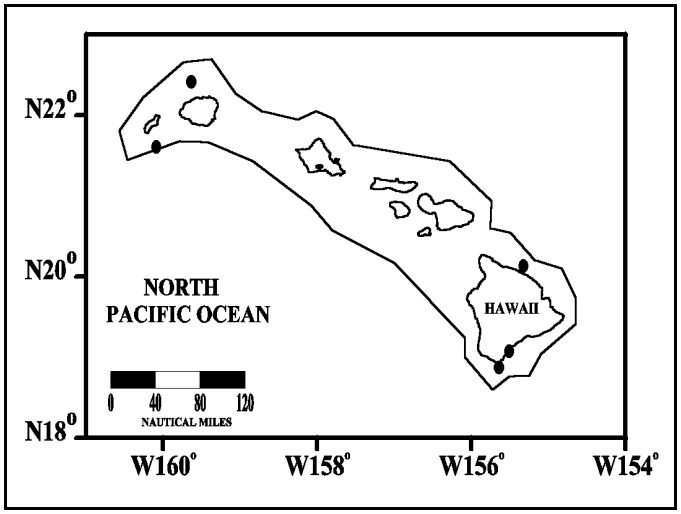

Figure 1. Cuvier's beaked whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Wade and Gerrodette (1993) made an estimate for Cuvier's beaked whales in the eastern tropical Pacific, but it is not known whether any of these animals are part of the same population that occurs around 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. Seven sightings of Cuvier's beaked whales were made. An abundance estimate of 43 (CV=0.51) Cuvier's beaked whales was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of Cuvier's beaked whales within the U.S. EEZ off Hawaii, because areas around the Northwest 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.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 29 Cuvier's beaked whales. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and does not include a large proportion of animals that were diving and therefore unavailable to be seen.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (29) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 0.3 Cuvier's beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of Cuvier's beaked whales in Hawaiian waters (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 dolphins are reported for all pelagic fisheries, and humpback whales have been entangled in longlines off the Hawaiian Islands (Nitta and Henderson 1993), but no takes of Cuvier's beaked whales have been documented. However, three unidentified whales and one unidentified cetacean were observed hooked in the Hawaiian longline fishery between 1994 and 1998 (Figure 2), with approximately 4.4% of all effort (measured as the number of hooks fished) observed. Observer descriptions and photographs of these interactions indicate that at least two of the unidentified whales may have been beaked whales, including one within the U.S. EEZ. The total interaction rate based on these two possible beaked whales extrapolates to a 5-year estimate of 45 (95% CI = 7-108), or an average of 9 interactions per year (Kleiber 1999). One of the two possible beaked whales was hooked in the fluke, and following the guidelines of a 1997 Serious Injury Workshop (Angliss and DeMaster 1998), this would not be considered a serious injury (defined under the MMPA as likely to result in mortality). The other interaction, which took place within the U.S. EEZ, involved a possible beaked whale that was hooked but broke the line and swam away before the location of the hook could be ascertained. Therefore, no determination can be made regarding the severity of this second injury. Reports for other odontocetes indicate they may also become hooked in the mouth or ingest the hook, and that they may occasionally become entangled in the fishing line. Insufficient information is available to evaluate whether some of these unidentified whales may have been Cuvier's beaked whales.

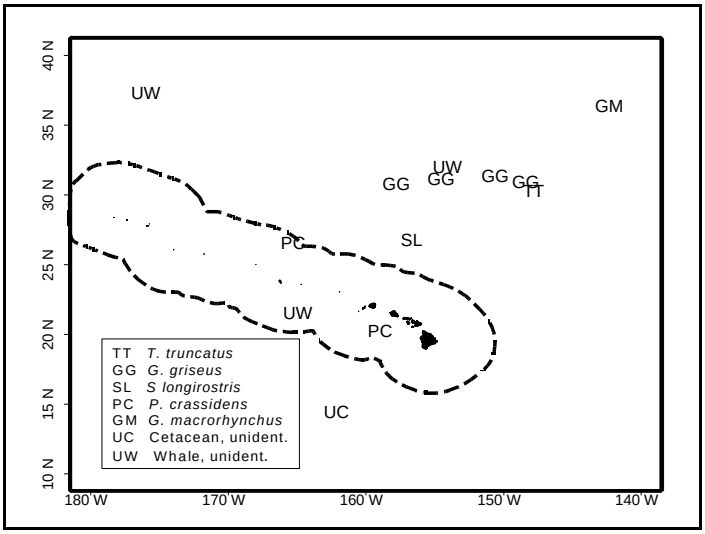

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); UW = unidentified whale; UC = unidentified cetacean. The two westernmost unidentified whales may have been Cuvier's beaked whales.

STATUS OF STOCK

The status of Cuvier's beaked whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on Cuvier's beaked whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA because there has been no reported fisheries related mortality within the U.S. EEZ. However, the effect of potential interactions of unidentified beaked whales (which may have been Cuvier's beaked whales) with the Hawaiian longline fishery in U.S. and international waters is not known. Insufficient information is available to determine whether the total fishery mortality and serious injury for Cuvier's beaked whales is insignificant and 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 Cuvier's beaked whales that feed in the oceans' "sound channel".

REFERENCES

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop 1-2 April 1997, Silver Spring, Maryland. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13. 48 pp.

Galbreath, E. C. 1963. Three beaked whales stranded on the Midway Islands, central Pacific Ocean. J. Mamm. 44:422-423.

Heyning, J. E. 1989. Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823. *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 4: The River Dolphins and Larger Toothed Whales, pp. 289-308. Academic Press, 442 pp.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Richards, L. P. 1952. Cuvier's beaked whale from Hawaii. J. Mamm. 33:255.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Wade, P. R. and R. P. 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.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 12/15/2000

PYGMY SPERM WHALE (*Kogia breviceps*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Pygmy sperm whales are found throughout the world in tropical and warm-temperate waters (Caldwell and Caldwell 1989). Between the years 1949 and 1982, at least nine strandings of this species were reported in the Hawaiian Islands (Tomich 1986; Nitta 1991). Shallenberger (1981) reported three sightings off Oahu and Maui. Two sightings of pygmy or dwarf sperm whales were made between Hawaii and Maui during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (Figure 1; Mobley et al. 1999). A stranded calf was held for several days at Sea Life Park (Pryor 1975:94). Nothing is known about stock structure for this species. For the Marine Mammal Protection Act (MMPA) stock assessment reports, pygmy sperm whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) Hawaiian waters (this report), and 2) waters off California, Oregon and Washington.

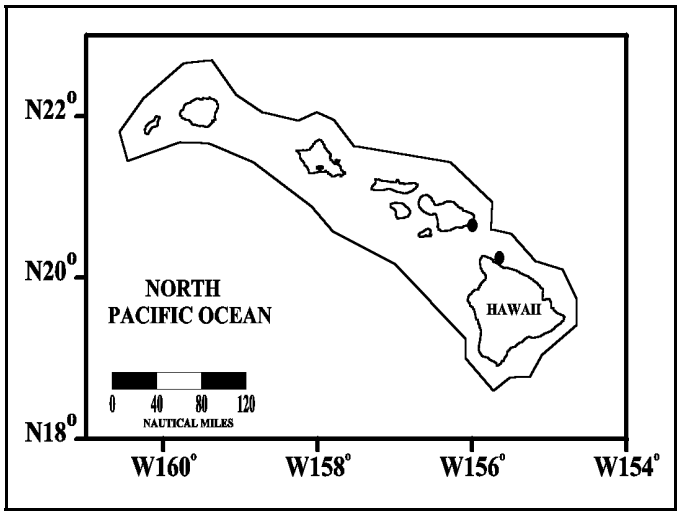

Figure 1. Pygmy or dwarf sperm whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

No data are available to estimate population size for this species in the central Pacific. 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. Two sightings of five pygmy or dwarf sperm whales were made; however these sightings were excluded during recent abundance analyses (Mobley et al. 2000), because they were made during poor observation conditions. Therefore, no abundance estimate is available for pygmy sperm whales within Hawaiian waters.

Minimum Population Estimate

No data are available to provide a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

No PBR can be calculated for this stock at this time.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of pygmy sperm whales in Hawaiian waters (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian

waters and 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 have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but no interactions with pygmy sperm whales have been documented. None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999).

STATUS OF STOCK

The status of pygmy sperm whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on pygmy sperm whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA because there has been no reported fisheries related mortality. The total fishery mortality and serious injury for pygmy sperm whales is zero and therefore can be considered to be insignificant and 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 pygmy sperm whales that feed in the oceans' "sound channel".

REFERENCES

Caldwell, D. K. and M. C. Caldwell. 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838): Dwarf sperm whale *Kogia simus* Owen, 1866. *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 4: The River Dolphins and Larger Toothed Whales, pp. 235-260. Academic Press, 442 pp.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, 2570 Dole St, Honolulu, HI, 96822-2396.

Mobley, J. R., Jr., R. A. Grotefendt, P. H. Forestell, and A. Frankel. 1999. Results of aerial surveys of marine mammals in the major Hawaiian Islands (1993-98): Report to the Acoustic Thermometry of Ocean Climate Marine Mammal Research Program (ATOC MMRP) (unpublished). 39 pp.

Mobley, J. R., Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Pryor, K. 1975. Lads Before the Wind: Adventures in Porpoise Training. Harper and Row, New York, 278 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Tomich, P. Q. 1986. Mammals in Hawaii: A Synopsis and Notational Bibliography. Bishop Museum Press, Hawaii, 375 pp.

Revised 12/15/2000

DWARF SPERM WHALE (*Kogia sima*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Dwarf sperm whales are found throughout the world in tropical to warm-temperate waters (Nagorsen 1985). One sighting in an unspecified locality, one stranding on Oahu (Tomich 1986), and one stranding on Lanai (Nitta 1991) constitute the only evidence that this species inhabits Hawaiian waters (Tomich 1986). Two sightings of pygmy or dwarf sperm whales were made between Hawaii and Maui during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (Figure 1; Mobley et al. 1999). The difficulty of detecting and identifying it at sea, as well as its confusion with the pygmy sperm whale, may partially explain the paucity of records. For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock of dwarf sperm whales including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands. Rice (1998) recently argued that the species name *simus*, is incorrect and should be replaced by *sima*. This change is not taxonomic, but merely reflects rules of Latin usage.

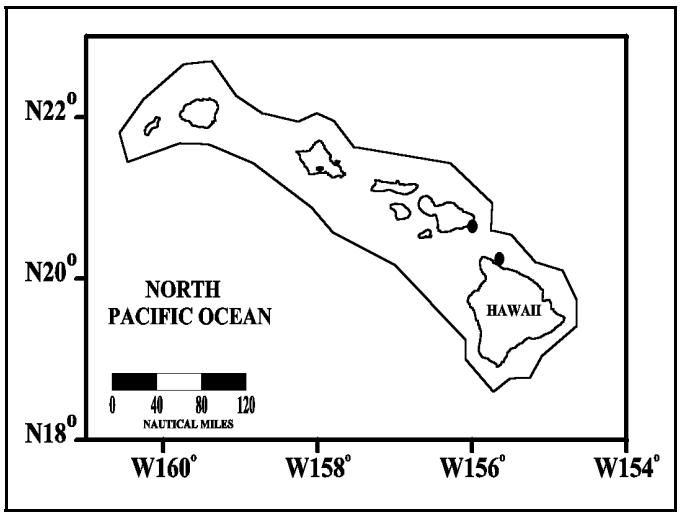

Figure 1. Pygmy or dwarf sperm whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Wade and Gerrodette (1993) provided an estimate for the eastern tropical Pacific, but no data are available to estimate population size for this species in the central Pacific. 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. Two sightings of five pygmy or dwarf sperm whales were made; however these sightings were excluded during recent abundance analyses (Mobley et al. 2000), because they were made during poor observation conditions. Therefore, no abundance estimate is available for dwarf sperm whales within Hawaiian waters.

Minimum Population Estimate

No data are available for a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

No PBR can be calculated for this species at this time.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of dwarf sperm whales in Hawaiian waters (Nitta and Henderson 1993). However, mortality of other

cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but no interactions with dwarf sperm whales have been documented. None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999).

STATUS OF STOCK

The status of dwarf sperm whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on dwarf sperm whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA because there has been no reported fisheries related mortality. The total fishery mortality and serious injury for dwarf sperm whales is zero and therefore can be considered to be insignificant and 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 dwarf sperm whales that feed in the oceans' "sound channel".

REFERENCES

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Mobley, J. R., Jr., R. A. Grotefendt, P. H. Forestell, and A. Frankel. 1999. Results of aerial surveys of marine mammals in the major Hawaiian Islands (1993-98): Report to the Acoustic Thermometry of Ocean Climate Marine Mammal Research Program (ATOC MMRP) (unpublished). 39 pp.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nagorsen, D. 1985. Kogia simus. Mamm. Spec. 239:1-6.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Rice, D.W. 1998. Marine Mammals of the World Systematics and Distribution. Special Publication Number 4 The Society of Marine Mammalogy. Douglas Wartzok (ed.). 231 pp.

Tomich, P. Q. 1986. Mammals in Hawaii: A Synopsis and Notational Bibliography. Bishop Museum Press, Hawaii, 375 pp.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

Revised 12/15/2000

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 five strandings have been reported from Oahu, Kauai (Nitta 1991) and Kure Atoll (Woodward 1972). Sperm whales have also been sighted around several of the Northwestern Hawaiian Islands (Rice 1960), off the main island of Hawaii (Lee 1993; Mobley et al. 1999, see Figure 1), 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).

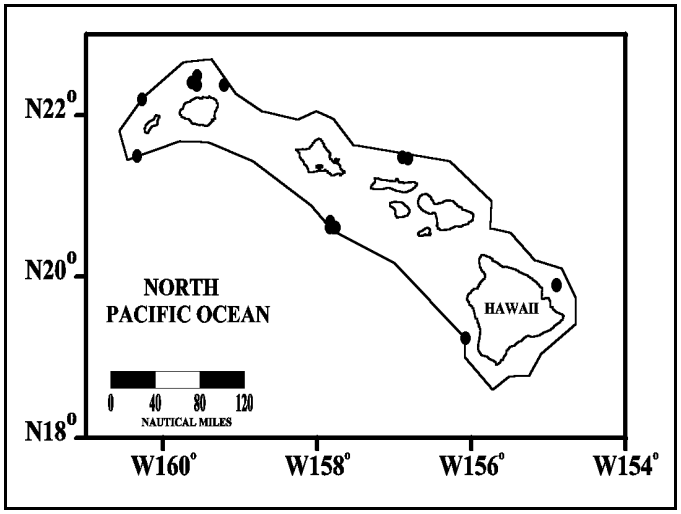

Figure 1. Sperm whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

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. 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). 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 Hawaii. 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 recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of sperm whales within the U.S. EEZ off Hawaii, because areas around the Northwest 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.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 43 sperm whales. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and does not include a large proportion of animals that were diving and therefore unavailable to be seen.

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 (43) 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), resulting in a PBR of 0.4 sperm whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of recent direct or incidental takes of sperm whales in Hawaiian waters (Nitta and Henderson 1993). However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 dolphins are reported for all pelagic fisheries, and humpback whales have been entangled in longlines off the Hawaiian Islands (Nitta and Henderson 1993), but no takes of sperm whales have been documented. None were observed hooked in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999).

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. The total fishery mortality and serious injury for sperm whales is zero and therefore can be considered to be insignificant and 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

Allen, K. R. 1980. Size distribution of male sperm whales in the pelagic catches. Rep. Int. Whal. Commn. Special Issue 2:51-56.

Allison, C. International Whaling Commission. The Red House, 135 Station Road, Impington, Cambridge, UK CB4 9NP.

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). xx pp.

Bannister, J. and E. Mitchell. 1980. North Pacific sperm whale stock identity: distributional evidence from Maury and Townsend charts. Rep. Int. Whal. Commn. (Spec. Iss. 2):219-230.

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.

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).

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.

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

Gilmore, R. M. 1959. On the mass strandings of sperm whales. Pac. Nat. 1(9-10):3-15.

Gosho, M. E., D. W. Rice, and J. M. Breiwick. 1984. The sperm whale *Physeter macrocephalus*. Mar. Fish. Rev. 46(4):54-64.

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).

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. NOAA Tech.Mem. NMFS 181, 184pp.

Mesnick, S. Southwest Fisheries Science Center, NMFS, P.O. Box 271, La Jolla, California, 92038.

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.

Mobley, J. R., Jr., R. A. Grotefendt, P. H. Forestell, and A. Frankel. 1999. Results of aerial surveys of marine mammals in the major Hawaiian Islands (1993-98): Report to the Acoustic Thermometry of Ocean Climate Marine Mammal Research Program (ATOC MMRP) (unpublished). 39 pp.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Ohsumi, S. 1980. Catches of sperm whales by modern whaling in the North Pacific. Rep. Int. Whal. Commn. (Spec. Iss. 2):11-18.
Ohsumi, S. and Y. Masaki. 1977. Stocks and trends of abundance of the sperm whale in the North Pacific. Rep. Int. Whal. Commn. 27:167-175.
Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.
Rice, D. W. 1960. Distribution of the bottle-nosed dolphin in the leeward Hawaiian Islands. J. Mamm. 41:407-408.
Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.
Rice, D. W. 1989. Sperm whale *Physeter macrocephalus* Linneaus, 1758. *In*: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 4: The River Dolphins and Larger Toothed Whales, pp. 177-233. Academic Press, 442 pp.
Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.
Thompson, P. O. and W. A. Friedl. 1982. A long term study of low frequency sound from several species of whales off Oahu, Hawaii. Cetology 45:1-19.
Townsend, C. H. 1935. The distribution of certain whales as shown by logbook records of American whaleships. Zoologica 19:1-50.
Wade, P. R. and R. P. 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.
Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.
Woodward, P. W. 1972. The natural history of Kure Atoll, northwestern Hawaiian Islands. Atoll Res. Bull. 164:302.

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BLUE WHALE (*Balaenoptera musculus*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Blue whales are extremely rare in Hawaii. The only published sighting record is that of Berzin and Rovnin (1966) north of the Hawaiian Islands. Additional evidence that blue whales occur in this area comes from acoustic recordings made off Oahu and Midway Islands (Northrop et al. 1971; Thompson and Friedl 1982; McDonald and Fox 1999). Although the exact positions of the whales producing the sounds could not be determined, at least some of them were within the U.S. Exclusive Economic Zone. The recordings made off Oahu showed bimodal peaks throughout the year, suggesting that the animals were migrating into the area in summer and winter.

The stock structure of blue whales in the North Pacific is uncertain (Mizroch et al. 1984; Reilly and Thayer 1990; Reeves et al. 1998). The International Whaling Commission (IWC) has formally considered only one management stock for blue whales in the North Pacific (Donovan 1991), but now this ocean is thought to include up to five populations (Reeves et al. 1998), with two occurring within the U.S. EEZ. One group of animals feeds in California waters in summer/fall (from June to November) and migrates south to productive areas off Mexico and as far south as the Costa Rica Dome (10^{o} N) in winter/spring (Mate et al. 1999, Stafford et al. 1999). Rice (1974) hypothesized that blue whales from Baja California migrated far offshore to fed in the eastern Aleutians or Gulf of Alaska and returned to feed in California waters; however, he has more recently concluded that the California population is separate from the Gulf of Alaska population (Rice 1992). Length frequency analyses (Gilpatrick et al. 1996) and photo-identification studies (Calambokidis et al. 1995) support separate population status for blue whales feeding off California and those feeding in Alaskan waters. Whaling catch data indicate that whales feeding along the Aleutian Islands are probably part of a central Pacific stock (Reeves et al. 1998), which may migrate to offshore waters north of Hawaii in winter (Berzin and Rovnin 1966). Recently, however, blue whale feeding aggregations have not been found in Alaska despite several surveys (Leatherwood et al. 1982; Stewart et al. 1987; Forney and Brownell 1996). For management in U.S. Pacific waters outside the continental EEZ, the Hawaiian stock includes only those whales within the EEZ of the Hawaiian Islands. One other stock of North Pacific blue whales (off California and Mexico) is recognized in the Marine Mammal Protection Act (MMPA) stock Assessment Reports.

POPULATION SIZE

From ship line-transect surveys, Wade and Gerrodette (1993) estimated 1,400 blue whales for the eastern tropical Pacific. A weighted average estimate of 1,940 blue whales is available for California, Oregon and Washington, based on 1991-96 shipboard line-transect surveys (Barlow 1997) and photographic mark-recapture estimates (Calambokidis and Steiger 1994). No data are available to estimate population size for any other North Pacific blue whale population, including the putative central stock that apparently summered along the Aleutians and wintered north of Hawaii. A summer 1994 shipboard survey within the historical whaling grounds south of the Aleutian Islands yielded no blue whale sightings (Forney and Brownell 1996), nor did a total of twelve aerial surveys conducted in 1993-98 within about 25 nmi of the main Hawaiian Islands as part of the Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study (Mobley et al. 2000).

Minimum Population Estimate

No data are available to provide a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

No PBR can be calculated for this stock at this time.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of recent direct or incidental takes of blue whales in Hawaiian waters. However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 dolphins are reported for all pelagic fisheries, and humpback whales have been entangled in longlines off the Hawaiian Islands, but no takes of blue whales have been documented (Nitta and Henderson 1993). None were observed hooked or entangled in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999).

Historical Mortality

At least 9,500 blue whales were taken by commercial whalers throughout the North Pacific between 1910 and 1965 (Ohsumi and Wada 1972). Some proportion of this total may have been from a population or populations that migrate seasonally into the Hawaiian EEZ. The species has been protected in the North Pacific by the IWC since 1966.

STATUS OF STOCK

The status of blue whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Blue 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. The total fishery mortality and serious injury for blue whales is zero and therefore can be considered to be insignificant and 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 blue whales (Reeves et al. 1998).

REFERENCES

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. Admin. Rept. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 25 pp.

Berzin, A. A. and A. A. Rovnin. 1966. Distribution and migration of whales in the northeastern part of the Pacific Ocean, Bering and Chukchi Seas. Izv. Tikhookean. Nauchno-issled, Inst. Rybn. Khoz. Okeanogr. (TINRO) 58:179-207. {In Russian}. (Translated by U.S. Dep. Inter., Bur. Commer. Fish., Seattle, Washington, 1966, pp. 103-106 *In:* Panin, K. I. (ed) Soviet Research on marine mammals of the Far East).

Calambokidis, J., R. Sears, G. H. Steiger, and J. Evenson. 1995. Movement and stock structure of blue whales in the eastern North Pacific. P.19 *In*: Proceedings of the Eleventh Biennial Conference on the Biology of Marine Mammals, Orlando, FL, 14-18 December 1995 (Abstract). Society for Marine Mammalogy, Lawrence, KS.

Calambokidis, J., and G. H. Steiger. 1994. Population assessment of humpback and blue whales using photo-identification from 1993 surveys off California. Final Contract Report to Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 31 pp.

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

Forney, K. A. and Brownell, R. L., Jr. 1996. Preliminary report of the 1994 Aleutian Island Marine Mammal Survey. Paper SC/48/O11 presented to the International Whaling Commission, June 1996 (unpublished).

Gilpatrick, J., W. Perryman, M. Lynn, and M. A. DeAngelis. 1996. Geographic populations of blue whales (*Balaenoptera musculus*) in the North Pacific Ocean investigated from whaling records and aerial photogrammetry. Paper SC/47/NP4 presented to the International Whaling Commission, May 1995 (unpublished).

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. NOAA Technical Rept. NMFS Circular 444. 245 pp.

Mate, B.R., B.A. Lagerquist, and J. Calambokidis. Movements of North Pacific blue whales during the feeding season off southern California and their southern fall migration. Mar. Mamm. Sci. 15(4):1246-1257.

Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984. The blue whale, *Balaenoptera musculus*. Mar. Fish. Rev. 46(4):15-19.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Northrop, J., W. C. Cummings, and M. F. Morrison. 1971. Underwater 20-Hz signals recorded near Midway Island. J. Acoust. Soc. Am. 49:1909-1910.

Ohsumi, S. and S. Wada. 1972. Stock assessment of blue whales in the North Pacific. Int. Whal. Commn. Sci. Comm. Rep., 20 pp.

Perrin, W.F., G.P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Spec. Iss. 15, 629pp.

Reeves, R. R., P. J. Clapham, R. L. Brownell, Jr., and G. K. Silber. 1998. Recovery plan for the blue whale (Balaenoptera musculus). Office of Protected Resources, NMFS, NOAA, Silver Spring, Maryland. 30 pp.

Reilly, S. B. and V. G. Thayer. 1990. Blue whale (*Balaenoptera musculus*) distribution in the eastern tropical Pacific. Mar. Mamm. Sci. 6:265-277.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

Rice, D. W. 1992. The blue whales of the southeastern North Pacific Ocean. pp. 1-3 In. Alaska Fisheries Science Center, Quart. Rept. Oct.-Dec.

Stafford, K.M., S.L. Nieukirk, and C.G. Fox. 1999. An acoustic link between blue whales in the eastern tropical Pacific and the northeast Pacific. Mar. Mamm. Sci. 15(4):1258-1268.

Stewart, B. S., S. A. Karl, P. K. Yochem, S. Leatherwood, and J. L. Laake. 1987. Aerial surveys for cetaceans in the former Akutan, Alaska, whaling grounds. Arctic 40(1):33-42.

Thompson, P. O. and W. A. Friedl. 1982. A long term study of low frequency sound from several species of whales off Oahu, Hawaii. Cetology 45:1-19.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

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FIN WHALE (*Balaenoptera physalus*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Fin whales are found throughout all oceans and seas of the world from tropical to polar latitudes. They are rare in Hawaiian waters. Balcomb (1987) observed 8-12 fin whales in a multispecies feeding assemblage on 20 May 1966 approx. 250 mi. south of Honolulu. Additional sightings were reported north of Oahu in May 1976 and in the Kauai Channel in February 1979 (Shallenberger 1981). More recently, a single fin whale was observed north of Kauai in February 1994 (Mobley et al. 1996). A single stranding has been reported on Maui (Shallenberger 1981). Thompson and Friedl (1982; and see Northrop et al. 1968) suggested that fin whales migrate into Hawaiian waters mainly in fall and winter, based on acoustic recordings off Oahu and Midway Islands. Although the exact positions of the whales producing the sounds could not be determined, at least some of them were almost certainly within the U.S. Exclusive Economic Zone. More recently, McDonald and Fox (1999) reported an average of 0.027 calling fin whales per 1000^2 km (grouped by 8-hr periods) based on passive acoustic recordings within about 16 km of the north shore of Oahu.

The International Whaling Commission (IWC) recognized two stocks of fin whales in the North Pacific: the East China Sea and the rest of the North Pacific (Donovan 1991). Mizroch et al. (1984) cites evidence for additional fin whale subpopulations in the North Pacific. There is still insufficient information to accurately determine population structure, but from a conservation perspective it may be risky to assume panmixia in the entire North Pacific. In the North Atlantic, fin whales were locally depleted in some feeding areas by commercial whaling (Mizroch et al. 1984), in part because subpopulations were not recognized. The Marine Mammal Protection Act (MMPA) stock assessment reports recognize three stocks of fin whales in the North Pacific: 1) the Hawaii stock (this report), 2) the California/Oregon/Washington stock, and 3) the Alaska stock.

POPULATION SIZE

No data are available to estimate population size. 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 1993-98 (Mobley et al. 2000). Only one sighting of a single fin whale was made (Mobley et al. 1996), and therefore no meaningful abundance estimate could be calculated. Using passive acoustic detections from a hydrophone north of Oahu, MacDonald and Fox (1999) estimate an average density of 0.027 calling fin whales per 1000 km^2 within about 16 km from shore. However, the relationship between the number of whales present and the number of calls detected is not known, and therefore this acoustic method does not provide an estimate of absolute abundance for fin whales.

Minimum Population Estimate

No data are available to provide a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

No PBR can be calculated for this stock at this time.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of recent direct or incidental takes of fin whales in Hawaiian waters. However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 dolphins are reported for all pelagic fisheries, and humpback whales have been entangled in longlines off the Hawaiian Islands (Nitta and Henderson 1993), but no takes of fin whales have been documented. None were observed hooked or entangled in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999).

Historical Mortality

Large numbers of fin whales were taken by commercial whalers throughout the North Pacific from the early 20th century until the 1970s (Tønnessen and Johnsen 1982). Approximately 46,000 fin whales were taken from the North Pacific by commercial whalers between 1947 and 1987 (C. Allison, IWC, pers. comm.). Some of the whales taken may have been from a population or populations that migrate seasonally into the Hawaiian EEZ. The species has been protected in the North Pacific by the IWC since 1976.

STATUS OF STOCK

The status of fin whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Fin 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. The total fishery mortality and serious injury for fin whales is zero and therefore can be considered to be insignificant and 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.

REFERENCES

Allison, C. International Whaling Commission. The Red House, 135 Station Road, Impington, Cambridge, UK CB4 9NP.

Balcomb, K. C., III. 1987. The Whales of Hawaii. Marine Mammal Fund, 99 pp.

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

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

McDonald, M. A., and C. G. Fox. 1999. Passive acoustic methods applied to fin whale population density estimation. J. Acoust. Soc. Am. 105: 2643-2651.

Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984. The fin whale, *Balaenoptera physalus* Mar. Fish. Rev. 46(4):20-24.

Mobley, J. R., Jr., M. Smultea, T. Norris, and D. Weller. 1996. Fin whale sighting north of Kaua'i, Hawai'i. Pacific Science 50:230-233.

Mobley, J. R., Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Northrop, J., W. C. Cummings, and P. O. Thompson. 1968. 20-Hz signals observed in the central Pacific. J. Acoust. Soc. Am. 43:383-384.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Thompson, P. O. and W. A. Friedl. 1982. A long term study of low frequency sound from several species of whales off Oahu, Hawaii. Cetology 45:1-19.

Tønnessen, J. N. and A. O. Johnsen. 1982. The History of Modern Whaling. Hurst, 789 pp.

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BRYDE'S WHALE (*Balaenoptera edeni*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bryde's whales occur in tropical and warm temperate waters throughout the world. Shallenberger (1981) reported a sighting of a Bryde's whale southeast of Nihoa in April 1977 (see DeLong and Brownell 1977; Leatherwood et al. 1982: Fig. 39c). Leatherwood et al. (1982) described the species as relatively abundant in summer and fall on the Mellish and Miluoki banks northeast of Hawaii and around Midway Islands, but the basis for this statement was not explained. Ohsumi and Masaki (1975) reported the tagging of "many" Bryde's whales between the Bonin and Hawaiian Islands in the winters of 1971 and 1972 (Ohsumi 1977). With presently available evidence, there is no biological basis for defining separate stocks of Bryde's whales in the central North Pacific. Bryde's whales also occasionally occur off southern California (Morejohn and Rice 1973). For the MMPA stock assessment reports, Bryde's whales within the Pacific U.S. Exclusive Economic Zone are divided into two areas: 1) Hawaiian waters (this report), and 2) the eastern tropical Pacific (east of 150°W and including the Gulf of California and waters off California).

POPULATION SIZE

Tillman (1978) concluded from Japanese and Soviet CPUE data that the stock size in the North Pacific pelagic whaling grounds, mostly to the west of the Hawaiian Islands, declined from approximately 22,500 in 1971 to 17,800 in 1977. An estimate of 13,000 (CV=0.202) Bryde's whales was made from vessel surveys in the eastern tropical Pacific between 1986 and 1990 (Wade and Gerrodette 1993). The area to which this estimate applies is mainly east and somewhat south of the Hawaiian Islands, and it is not known whether these animals are part of the same population that occurs around 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 (Mobley et al. 2000). No sightings of Bryde's whales were made, and therefore no abundance estimate is available for Hawaiian waters.

Minimum Population Estimate

No data are available for a minimum population estimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

No PBR can be calculated for this stock at this time.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

No estimate of annual human-caused mortality and serious injury is available as there are no reports of recent direct or incidental takes of Bryde's whales in Hawaiian waters. However, mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and 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 dolphins are reported for all pelagic fisheries, and humpback whales have been entangled in longlines off the Hawaiian Islands (Nitta and Henderson 1993), but no takes of Bryde's whales have been documented. None were observed hooked or entangled in the Hawaiian longline fishery between 1994 and 1998, with approximately 4.4% of all effort (measured as the number of hooks fished) observed (Kleiber 1999).

Historical Mortality

Small numbers of Bryde's whales were taken near the Northwestern Hawaiian Islands by Japanese and Soviet whaling fleets during the early 1970s (Ohsumi 1977). Pelagic whaling for Bryde's whales in the North Pacific ended after the 1979 season (IWC 1981), and coastal whaling for this species ended in the western Pacific in 1987 (IWC 1989).

STATUS OF STOCK

The status of Bryde's whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Although information on Bryde's whales in Hawaiian waters is limited, this stock would not be considered strategic under the 1994 amendments to the MMPA because there has been no reported fisheries related mortality. The total fishery mortality and serious injury for Bryde's whales is zero and therefore can be considered to be insignificant and 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.

REFERENCES

DeLong, R. L. and R. L. Brownell, Jr. 1977. Hawaiian monk seal (*Monachus schauinslandi*) habitat and population survey in the northwestern (Leeward) Hawaiian Islands, April 1977. Northwest Alaska Fish Cent. Proc. Rep., 43 pp.

International Whaling Commission. 1981. Japan. Progress report on cetacean research June 1979-May 1980. Rep. Int. Whal. Commn. 31:195-200.

International Whaling Commission. 1989. Japan. Progress report on cetacean research June 1987 to April 1988. Rep. Int. Whal. Commn. 39:201-204.

Kleiber, P. 1999. Estimates of marine mammal takes in the Hawaiian longline fishery. (Unpublished). Southwest Fisheries Science Center, NMFS, 2570 Dole St, Honolulu, HI, 96822-2396.

Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent arctic waters: A guide to their identification. NOAA Tech. Rep. NMFS 444, 245 pp.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Morejohn, G. V. and D. W. Rice. 1973. First record of Bryde's whale (*Balaenoptera edeni*) off California. Cal. Fish Game 59:313-315.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Ohsumi, S. 1977. Stocks and trends of abundance of the sperm whale in the North Pacific. Rep. Int. Whal. Commn. 27:167-175.

Ohsumi, S. and Y. Masaki. 1975. Japanese whale marking in the North Pacific, 1963-72. Bull. Far Seas Fish. Res. Lab. 12:171-219.

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Tillman, M. F. 1978. Modified Delury estimates of the North Pacific Bryde's whale stock. Rep. Int. Whal. Commn. 28:315-317.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep. Int. Whal. Commn. 43:477-493.

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Appendix 1. Description of U.S. Commercial Fisheries

This appendix describes commercial fisheries that are currently active in California, Oregon, Washington, and Hawaii and that interact or may interact with marine mammals. The first three sections describe sources of marine mammal mortality data for these fisheries. The fourth section describes the commercial fisheries for these states. A list of all known fisheries for these states was published in the Federal Register, vol. 64, no. 36 dated 24 February 1999. Category I fisheries are described in more detail. Category II and III fisheries are summarized to the extent possible. Following the fishery descriptions is a table giving basic characteristics of California gillnet fisheries and a series of figures. Figures 1-10 show approximate locations of fishing effort and marine mammal entanglements for the California shark/swordfish drift gillnet fishery. Figures 11-17 show set locations of observed sets in 1994, observed entanglements 1990-1994 and estimated effort for 1994-1998 for the set gillnet fishery. Figures 18 and 19 show estimated and observed effort and percent coverage for both the drift and set gillnet fisheries.

1. Sources of Mortality/Injury Data

There are three major sources of marine mammal mortality/injury data for the active commercial fisheries in California, Oregon, and Washington. These sources are the NMFS Observer Programs, the Marine Mammal Authorization Program (MMAP) data, and the NMFS Marine Mammal Stranding Network (MMSN) data. Each of these data sources has a unique objective. The National Marine Fisheries Service (NMFS) observes about 12-15% of the annual CA swordfish drift-net effort and (as of 1999) about 20% of the annual CA halibut/angel shark set-net effort in the NMFS Observer Program. Data from these observer programs are combined with estimates of total effort provided by the California Department of Fish and Game (CDFG), to estimate marine mammal mortality. Data on mammal mortality and injury are reported to the MMAP by fishers in any commercial fisheries. Marine mammal mortality and injury is also monitored by the NMFS Marine Mammal Stranding Network. Data provided by the MMSN is not duplicated by either the NMFS Observer Program or MMAP reporting. Human-related data from the MMSN include occurrences of mortality due to entrainment in power station intakes, ship strikes, shooting, net fishery entanglement (with net remaining on animal), and ingestion of hooks.

2. Marine Mammal Reporting from Fisheries

The Marine Mammal Exemption Program (MMEP) was put into place in mid-1989 as a result of the 1988 amendments to the MMPA. It required fishers to register with NMFS and to complete annual logbooks detailing each day's fishing activity, including: date fished, hours fished, area fished, marine mammal species involved, injured and killed due to gear interactions, and marine mammal species harassed, injured and killed due to deterrence from gear or catch. If the marine mammal was deterred, the method of deterrence was required, as well as indication of its effectiveness. Fishers were also required to report whether there were any losses of catch or gear due to marine mammals. These logbooks were submitted to NMFS on an annual basis, as a prerequisite to renewing their registration. Logbook data are available for part of the 1989 and 1991-1994. Logbook data received for part of 1994 and 1995 was not entered into the MMEP logbook database in order to focus staff efforts on implementing the 1994 amendments to the MMPA.

In 1994, the MMPA was amended again to implement a long-term regime for managing mammal interactions with commercial fisheries (the Marine Mammal Authorization Program, or MMAP). Logbooks are no longer required - instead vessel owners/operators in any commercial fishery (Category I, II, or III) are required to submit one-page pre-printed reports for all interactions (including those that occur while an observer is onboard) resulting in an injury or mortality to a marine mammal. The report must include owner/operator's name and address, vessel name and ID, where and when the interaction occurred, the fishery, species involved, and type of injury (if the animal was released alive). These postage-paid report forms are mailed to all Category I and II fishery participants that have registered with NMFS, and must be completed and returned to NMFS within 48 hours of returning to port for trips in which a marine mammal injury or mortality occurred. Since the inception of this system in April 1996, the number of interactions have been grossly under-reported by drift-net fishers. In 1997, the first full year of reporting, only 54 interactions were reported by fishers, far fewer than the number (85) reported by the observers which is based on observing only one-fifth of the

total effort (Table 1).

3. NMFS Marine Mammal Stranding Network data

Reported strandings of cetaceans and pinnipeds in both California and Oregon/Washington have steadily increased since 1996. In California, for the years 1996 through 1998 there were 89, 101 and 120 cetacean strandings respectively and 1,449, 2,061, 3,568 pinniped strandings respectively (Table 2). California human related cetacean and pinniped strandings of interest include 1 Pacific white-sided dolphin ('97), 1 Peruvian beaked whale ('98), 14 gray whales (5-'96,6-'97,3-'98), 2 fin whales ('96,'97), 1 humpback whale ('97) and 1 unidentified balaenopterid ('97), 2 Steller sea lions ('98). In Oregon/Washington for the same years, there were 18, 20 and 43 cetacean strandings respectively and 188, 254 and 321 pinniped strandings respectively. A stranding of interest in Oregon/Washington is 1 Steller Sea Lion in 1997. Human-related causes of mortality include: entrainment in power station intakes, shooting, net fishery entanglement, and hook/line, set-net and trap fishery interaction.

4. Fishery Descriptions

Category I, CA/OR thresher shark/swordfish drift gillnet fishery

Number of permit holders: The number of eligible permit holders in California for 1994-1998 are 162, 185, 167, 120 and 147 respectively.[1] Since 1995, 10 developmental ("unlimited") fishery permits and a smaller number of "limited" swordfish landing permits have been issued by the state of Oregon.

Number of active permit holders: The number of vessels actively fishing during 1995 and 1997-1998 was 130, 115 and 123 (3 from Oregon) respectively. The number of permit holders observed by NMFS from 1994-1998 were 70, 52, 51, 74 and 67 respectively.[1]

Total effort: Both estimated and observed effort for the drift-net fishery during the calendar years 1990 through 1998 are shown in Figure 18. In 1998 there was an estimated 3,353 effort-days, where an effort-day is defined to be one day of effort by one vessel.[2] (In this fishery, 1 effort-day is equivalent to 1 set.). There were 636 (113 trips) of observed effort-days in 1998.

Geographic range: Effort in this fishery ranges from the U.S./Mexico border north to waters off the state of Oregon. For this fishery there are area-season closures (see below). Figures 1-5 show locations of observed sets and Figures 6-10 show approximate locations of observed marine mammal entanglements for each year 1994 - 1998.

Seasons: This fishery is subject to season-area restrictions. From February 1 to May 15 effort must be further than 200 nautical miles (nmi) from shore; from May 16 to August 14, effort must be further than 75 nmi from shore, and from August 15 to January 31 there is only the 3 nmi off-shore restriction for all gillnets in southern California (see angel shark/halibut fishery below). The majority of the effort occurs from October through December.

Gear type and fishing method: Typical gear used for this fishery is a 1000 fathom gillnet with a stretched mesh size

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[1]Pers. Comm. Robert Read California Dept. of Fish and Game.

[2]Read, R. B. 1999. Effort estimates of California gill net fisheries: halibut-angel shark set net, shark-swordfish drift net, white seabass-yellowtail set/drift net, for January through December 1998 and each calendar quarter. Report submitted to NOAA Fisheries/National Marine Fisheries Service, Southwest Region in partial fulfillment of Cooperative Agreement No. NA77FX0349. Available from Southwest Fisheries Science Center, La Jolla, CA.

typically ranging from 18-22 inches (14 inch minimum). The net is set at dusk and allowed to drift during the night after which, it is retrieved. The fishing vessel is typically attached to one end of the net. Soak duration is typically 12-14 hours depending on the length of the night. Net extender lengths of a minimum 36 ft. became mandatory for the 1997-1998 fishing season. The use of acoustic warning devices (pingers) became mandatory 28 October 1997.

Regulations: This fishery is managed by the California Dept. of Fish and Game and by Oregon Dept. of Fish and Wildlife in accordance with state and federal laws.

Management type: The drift-net fishery is a limited entry fishery with seasonal closures and gear restrictions (see above). The state of Oregon restricts landing to swordfish only.

Comments: This fishery has had a NMFS observer program in place since July 1990. Due to bycatch of strategic stock including short-finned pilot whale, beaked whales, sperm whale and humpback whale, a Take Reduction Team was formed February 12, 1996. Since then, the implementation of increased extender lengths and the deployment of pingers has substantially decreased cetacean entanglement[3].

Category I, CA angel shark/halibut large mesh (>8.0 in) set gillnet fishery.

Number of permit holders: There is no specific permit category for this fishery. However, in 1996 there were an estimated 80 permit holders. Overall, the current number of legal permit holders for gill and trammel nets, excluding swordfish drift gillnets and herring gillnets for 1994 through 1998 are, respectively, 308, 300, 273, 219 and 265[4]. This general permit category includes the fishery, "CA. large mesh (>3.5") for other species" described below.

Number of active permit holders: At least 81; the number of permit holders observed by NMFS observers during 1994 was 22. Nine vessels have been observed in Monterey Bay during 1999. The number of boats fishing 1995 through 1998 were 58, 54, 71 and 81 respectively.[2]

Total effort: Both estimated and observed effort for the set-net fishery during calendar year 1990-1998 are shown in Figure 19. In 1998 there was an estimated 2,836 effort-days where an effort-day is defined to be one day of effort by one vessel (typically 2-4 sets). During 1994, an effort-day was equivalent to 3.62 sets (s.e. = 0.16). Figures 11-15 show estimated effort for the years 1994-1998. Beginning in 1994, a gillnet area closure was implemented. From Pt. Arguello south to the U.S./Mexico border, gillnets are restricted to waters farther than 3 nmi offshore and more than 1 nmi from any of the Channel Islands. Because of this closure, effort has decreased dramatically from about 7,000 days of effort in 1991 to about 2,500 days of effort in subsequent years. Use of gillnets north of Pt. Arguello (e.g. Monterey Bay effort) has been unaffected by this closure but is subject to other California Dept. of Fish and Game restrictions[5].

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[3]Barlow, Jay and Grant Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. IWC working paper SC/51/SM2.

[4]J. Spratt, California Dept. of Fish and Game (Monterey)

[5] **Statutory Description of California Set Gillnet Closures**
Closure One is "between a line extending 245° magnetic from the most westerly point of the west point of the Point Reyes headlands in Marin County and the westerly extension of the California-Oregon boundary." [CA Fish & Game Code section 8664.8(a)].
Closure Two is in waters which are "40 fathoms or less in depth at mean lower low water between a line extending 245° magnetic from the most westerly point of the west point of the Point Reyes headlands in marine County and a line extending 225° magnetic from Pillar Point at Half Moon Bay in San Mateo County" and "60 fathoms or less in depth at mean lower low water between a line extending 225° magnetic from Pillar Point at Half Moon Bay in San

Appendix 1. Fishery Descriptions

Geographic range: Effort in this fishery previously ranged from the U.S./Mexico border north to Monterey Bay and was localized in more productive areas: San Ysidro, San Diego, Oceanside, Newport, San Pedro, Ventura, Santa Barbara, Morro Bay, and Monterey Bay. Fishery effort is now predominantly in the Ventura Flats area off of Ventura, the San Pedro area between Pt. Vicente and Santa Catalina Island and in the Monterey Bay area.

Seasons: This fishery operates year round. Effort generally increases during the summer months and declines during the last three months of a year.

Gear type and fishing method: Typical gear used for this fishery is a 200 fathom gillnet with a stretched mesh size of 8.5 inches. The net is generally set during the day and allowed to soak for up to 2 days. Soak duration is typically 8-10, 19-24, or 44-49 hours. The depth of water ranges from 15-50 fathoms with most sets in water depths of 15-35 fathoms.

Regulations: This fishery is managed by the California Dept. of Fish and Game in accordance with state and federal laws.

Management type: The halibut/angel shark set-net fishery is a limited entry fishery with gear restrictions and area closures.

Comments: NMFS has re-established the (1990-1994) observer program for this fishery in Monterey Bay due to a suspected increase in harbor porpoise mortality caused by a shift in effort from the northern to the southern section of Monterey Bay. The most recent (11/1999) data clearly shows an increase in mortality for this species with extrapolated take exceeding PBR. Mortalities and injuries reported to the MMAP for California set gill net fisheries are given in Table 1. **On September 13, 2000, the California Department of Fish and Game (CDFG) restricted the halibut set gillnet fishery in central California to waters deeper than 60 fathoms, citing concerns over the continued mortality of common murres and decline of the southern sea otter population. The closure area extends from Point Reyes to Yankee Point in Monterey County and from Point Arguello to Point Sal in Santa Barbara County. The area from Yankee Point to Point Sal will remain open to halibut fishing outside of 30 fathoms. This closure is effective for 120 days and may be extended or reissued by the CDFG. The exclusion of this fishery from inshore waters less than 60 fathoms is expected to considerably reduce the mortality of harbor porpoise in Monterey Bay.**

Mateo County to a line extending 220º magnetic from the mouth of Waddell Creek in Santa Cruz County." [CA Fish & Game Code section 8664.8(b)].

Closure Three is in "that portion of District 18 north of a line extending due west from Point Sal in Santa Barbara County in waters 30 fathoms or less in depth at mean lower low water." [CA Fish & Game Code section 8664.5(b)].

Closure Four is "in waters less than 35 fathoms between a line running 180º true from Point Fermin and a line running 270º true from the south jetty of Newport Harbor." [CA Fish & Game Code section 8610.2(d)(3)].

Appendix 1. Fishery Descriptions

Category I, CA other species, large mesh (>3.5 in) set gillnet fisheries.
Note: This fishery was previously combined with the California halibut/angel shark fishery. Because marine mammal mortality estimates were determined specifically for that fishery, other large mesh set gillnet fisheries have been separately described here.

Number of permit holders: There is no specific permit category for this fishery. See the fishery "CA halibut/angel shark, large mesh (>8 in)" for the number of legal permit holders in the category gill/trammel nets.

Number of active permit holders:. The number of permit holders observed by NMFS observers during 1994 was 6. In the gillnet fishery for white sea bass and yellowtail, the number of vessels actively fishing in 1995-1998 were 20, 23, 28 and 59, respectively.[2]

Total effort: Total effort for these set-net fisheries is not currently estimated but the majority of effort is due to the white sea bass and yellowtail fishery. For this fishery, 1995-1998, there were an estimated 261, 276, 411 and 761 days of effort. The fisheries comprising this category are further described in Table 3.

Geographic range: Effort in this fishery ranges from the U.S./Mexico border north to Monterey Bay and is localized in more productive areas: San Ysidro, San Diego, Oceanside, Newport, San Pedro, Ventura, Santa Barbara, Morro Bay, and Monterey Bay. As with the halibut/angel-shark set-net fishery, effort from Pt. Arguello south to the U.S./Mexico border is restricted to waters farther than 3 nmi offshore and greater than 1 nmi from any of the Channel Islands.

Seasons: This fishery operates year round. Targeted species is typically determined by market demand on a short-term basis.

Gear type and fishing method: Typical gear used for this fishery is a 150-200 fathom gillnet. The mesh size depends on the target species but typical values observed are 6.0 and 6.5 inches. Typical characteristics for these fisheries are found in Table 3. Fishing methods vary according to target species but are similar to methods used in the halibut/angel shark fishery.

Regulations: This fishery is managed by the California Dept. of Fish and Game in accordance with state and federal laws.

Management type: These fisheries have gear restrictions and area closures.

Comments: This fishery is not currently observed by NMFS or the state of California. Mortalities and injuries reported to the MMAP for California set gill net fisheries are given in Table 1.

Category II, California Round Haul Fisheries.[6]
Note: This category includes purse seine, drum seine and lampara net fisheries for wetfish (anchovy, mackerel, and sardine), and tuna. Choice of targeted species is primarily driven by availability and varying market demand.

Number of permit holders: Number of permit holders is estimated at 175 for the wetfish fisheries (currently, tuna does not require a specific permit to operate other than a general commercial fishing permit). Starting January 1, 2000 under a new Coastal Pelagic Species Fishery Management Plan (CPS-FMP), a limited entry program will be initiated for the area south of 39^0 North latitude. Eligibility will require a minimal of 100 metric tons of CPS finfish be landed between January 1, 1993 through November 5, 1997.

[6]Pers. Comm. Mary Larson, CDFG biologist.

Appendix 1. Fishery Descriptions

Number of active permit holders: For the wetfish fishery, there are an estimated 65 vessels/persons actively fishing; for tuna, there are approximately 15 vessels/persons fishing.

Total effort: No estimate is currently available, however, overall effort has been relatively constant for these fisheries in recent years.

Geographic range: These fisheries occur along the coast of California predominantly from San Pedro, including the Channel Islands, north to San Francisco.

Seasons: This fishery operates year round. Targeted species vary seasonally with availability and market demand.

Gear type and fishing method: Purse seine, drum seine and lampara nets utilizing standard seining techniques.

Regulations: Starting on January 1, 2000 the wetfish fishery will be managed by PFMC in accordance with a CPS/FMP under federal laws.

Management type: The mackerel and sardine fisheries are quota fisheries, but no closure has been required by the State of California for the past 15 years.

Comments: Beginning in 1999 the sardine population is considered fully recovered since its collapse during the middle of the century. Typically, anchovy is targeted for bait or reduction while mackerel and sardine are destined for fresh fish , aquaculture or canning overseas.

Category II, WA Puget Sound Region salmon drift gillnet fishery. [7]

Number of permit holders: This commercial fishery includes all inland waters south of the US-Canada border and east of the Bonilla/Tatoosh line, at the entrance to the Strait of Juan de Fuca. Treaty Indian salmon gillnet fishing is not included in this commercial fishery. The total number of permit holders for this commercial fishery in 1990 was 1149. That number declined steadily to 773 total permits by 1998.

Number of active permit holders: Under the cooperative program that integrates issuance of Marine Mammal Authorization Certificates into the existing State license process, NMFS receives data on vessels that have completed the licensing process and are eligible to fish. These vessels are a subset of the total permits extant (773 in 1998), and the remainder of the permits are inactive and do not participate in the fishery during a given year. The number of "active" permits is assumed to be equal to or less than the number of permits that are eligible to fish. For 1996 the number of active permits was 552, 633 in 1997 and 559 in 1998. The total number of permits available has been reduced, from 1995 to present, through combined State and federal license buy-back programs and is not expected to return to previous levels.

Total effort: Effort in the Puget Sound salmon drift gillnet fishery is regulated by systematic openings and closures that are specific to area and target salmon species. Since 1994, the number of active vessels in the Puget Sound drift gillnet fishery has declined. In addition, at least one major portion of the fishery, the previously observed sockeye fishery in areas 7 and 7A, has experienced reductions in available fishing time (openings). The number of days and total number of hours that the sockeye fishery remained open, approached the 1994 level only once (1997) in the period from 1995 through 1998. In the remaining years the available sockeye fishing time was less than half of the 1994 level.

Geographic Range: The fishery occurs in the inland marine waters south of the U.S./Canada border and east of the

[7]Descriptions of Washington and Oregon fisheries provided by the Northwest Region, NMFS.

Bonilla/Tatoosh line at the entrance to the Strait of Juan de Fuca. The inland waters are divided into smaller statistical catch areas which are regulated independently.

Seasons: This fishery has multiple seasons throughout the year that vary among local areas dependent on local salmon runs. The seasons are managed to access harvestable surplus of robust stocks of salmon while minimizing impacts on weak stocks.

Gear type and fishing methods: Vessels operating in this fishery use a drift gillnet of single web construction, not exceeding 300 fathoms in length. Minimum mesh size for gillnet gear varies by target species. Fishing directed at sockeye and pink salmon are limited to gillnet gear with a 5 inch minimum mesh and a 6 inch maximum, with an additional "bird mesh" requirement that the first 20 meshes below the corkline be constructed of 5 inch opaque white mesh for visibility; the chinook season has a 7 inch minimum mesh; the coho season has a 5 inch minimum mesh; and the chum season has a 6 to 6.25 inch minimum mesh. The depth of gillnets can vary depending upon the fishery and the area fished. Normally they range from 180 to 220 meshes in depth, with 180 meshes as a common depth. It is the intention of the fisher to keep the net off the bottom. The vessel is attached to one end of the net and drifts with the net. The entire net is periodically retrieved onto the vessel and catch is removed. Drift times vary depending on fishing area, tidal condition and catch.

Regulations: The fishery is a limited entry fishery with seasonal openings, area closures, and gear restrictions.

Management type: The fishery occurs in State waters and is managed by the Washington Department of Fish and Wildlife consistent with the U.S.-Canada Pacific Salmon Commission management regimes and the ocean salmon management objectives of the Pacific Fishery Management Council.

Comments: In 1993, observers were placed onboard vessels in a pilot program to monitor seabird and marine mammal interactions with fishing effort for several target salmon species in a number of areas throughout the Puget Sound region. In 1994 observer effort was concentrated in the sockeye fishery in areas 7 and 7A, where interactions with seabirds and marine mammals were most likely to occur. Incidental takes of harbor porpoise, Dall's porpoise and harbor seals have been documented in the fishery. The overall take of marine mammals for the salmon drift gillnet fisheries in Puget Sound is unlikely to have increased since the fisheries were last observed, owing to reductions in the number of participating vessels and available fishing time.

Category II, OR swordfish surface longline fishery.

Number of permit holders: The number of Oregon Developmental Fishery Permits for fishing swordfish using a floating longline is limited to 20. Nine (9) developmental swordfish longline permits were issued in 1995, one (1) in 1996, two (2) in 1997, three (3) in 1998, and four (4) in 1999.

Number of active permit holders: Based on landings of swordfish with this gear type, there were no active permit holders in this fishery during 1998 or 1999.

Total effort: In 1998, and again in 1999 there were no reported swordfish landings using longline gear.

Geographic range: This fishery occurs off the coast of Oregon. Swordfish longlines may not be fished within 25 nautical miles of the mainland.

Seasons: This fishery could occur year-round, however, effort would generally terminate by late fall.

Gear type: Fishing gear consists of a buoyed mainline fitted with leaders and baited hooks. The mainline is fished near the surface suspended from buoys (rather than anchored to the bottom as in groundfish longline fisheries). Swordfish

longlines may not exceed 1000 fathoms in length and must be attached at one end to the vessel when fishing. The gear is typically set in the evening and retrieved in the morning.

Regulations: The fishery is a limited entry fishery with gear and bycatch restrictions.

Management type: This fishery is managed by the Oregon Department of Fish and Wildlife, Developmental Fisheries Program.

Comments: The Developmental Fisheries Permit requires permit holders to take observers aboard if requested to do so, however, to date no observer placements have been made. No marine mammal interactions have been documented.

Category II, OR blue shark surface longline fishery.

Number of permit holders: The number of Oregon Developmental Fishery Permits for fishing blue shark using a floating longline is limited to 20. In 1995, six (6) of the available blue shark permits were issued, two (2) in 1996, four (4) in 1997 and no (0) permits were issued in 1998. For 1999, there again were no (0) developmental permits were issued for the blue shark longline fishery.

Number of active permit holders: There were no active permits in the blue shark longline fishery off Oregon during 1998 or 1999. The effort in this fishery prior to 1998 was estimated to be low based on the number of permits issued and very limited landings.

Total effort: Actual catch by the few developmental permit holders is unknown. Landings of blue shark by all vessels using longline gear totaled 3,628 pounds for the period 1995 through 1998 (477 lbs - '95, 871 lbs - '96, 542 lbs - '97, and 1,738 lbs - '98). Note that these landing totals are for all longline including blue shark landed incidental to the groundfish sunken longline fishery.

Geographic range: This fishery occurs off the coast of Oregon. There are no area restrictions for shark longline gear.

Seasons: This fishery occurs year-round, however, effort in this fishery generally terminates by late fall.

Gear type: Fishing gear consists of a buoyed mainline fitted with leaders and baited hooks. The mainline is fished near the surface suspended from buoys (rather than anchored to the bottom as in groundfish longline fisheries). Shark longlines must be marked at each terminal surface end with a pole and flag, an operating light, a radar reflector, and a buoy showing clear identification and gear owner. The gear is typically set in the evening and retrieved in the morning.

Regulations: The fishery is a limited entry fishery with gear and bycatch restrictions.

Management type: This fishery is managed by the Oregon Department of Fish and Wildlife, Developmental Fisheries Program.

Comments: The Developmental Fisheries Permit requires permit holders to take observers aboard if requested to do so, however, to date no observer placements have been made. No marine mammal interactions have been documented

Appendix 1. Fishery Descriptions

Category III, CA herring purse seine fishery.[8]

This fishery is composed of a roe herring fishery and a fresh herring fishery. The roe herring component has recently undergone some changes. During the early 1990's, there were 26 permits fishing for roe herring using round hauls (either purse seine or lampara nets). Between 1993 and 1998, all roe herring fishers converted their gear to gillnets with stretched mesh size less than 2.5 inches (which are not known to take mammals) as part of CDFG efforts to protect herring resources. There are presently 416 gillnet permits for the roe herring fishery in San Francisco Bay, and an additional 45 permits along the northern California coast (Tomales Bay, Humboldt Bay, and near Crescent City). This fishery begins in December (San Francisco Bay) or January (northern California) and ends when the quotas have been reached, but no later than mid-March. There are 10 permits available for the fresh herring round haul fishery (purse seine or lampara nets). This fishery is restricted to the non-spawning season, or approximately mid-March through the end of November. Fishing may take place in open ocean areas (e.g. Monterey Bay) or inside bays (e.g. San Francisco Bay).

Category II, CA squid purse seine fishery.[9]

Number of permit holders: A permit to participate in the squid fishery was required as of April 1, 1998 and must be renewed annually. Permits are classified as Market Squid Vessel permits which allow the vessel to light and/or catch squid and a Light Boat Owners permit that allows lighting of squid only. In the 1999/00 permit year there were 217 Market Squid Vessel permits and 51 Light Boat Owners permits.

Number of active permit holders: The number of active permits varies by year depending on market conditions and squid availability. During 1999/00 there were approximately 60 vessels active during some portion of the year. In the year of greatest squid landings (1996/97) and prior to the 1997/98 El Niño, approximately 105 vessels landed more than one ton of squid. During the 1998/99 fishing year, approximately 78 vessels landed more than one ton of squid. Additional vessels "lighted" for squid, but there are no data to arrive at a number.

Total effort: Effort can only be documented as successful fishing days (when vessels made landings). Therefore, days of unsuccessful effort or effort by light boats is undocumented. In the 1996/97 fishing year for vessels landing more than one ton during that year, approximately 4,202 landings were made. In 1998/99, approximately 1,125 landings were made. Environmental conditions have not been "normal" since 1996/97 for the squid industry and for the years since 1992/93 market demand has played a major role in fishing activity and landings.

Geographic range: The majority of the fishing activity and catches are made in southern California. Traditionally, the Channel Islands have been the area of greatest activity; coastal areas produce from 3%-30% of the catch. Monterey Bay has a squid fishery which is of historical significance in California. This fishery began in the mid 1800s and has been operational since that time. There is also some squid fishing that occurs at the northern end of the Bay off Santa Cruz.

Seasons: This fishery occurs year-round, however, effort in this fishery generally is greatest during the months of November through March in southern California and from May through September in the Monterey area. Unusual water conditions in 1998/99 have provided for an uncharacteristic fishery to take place in southern California during the months of April through June.

Gear type: There are several gears employed in this fishery. The majority of vessels use purse seine nets or lampara nets. Dip or brail nets are used by a few small vessels in southern California. Lights are used by almost all vessels to

[8] Pers. Comm. Diana Watters, biologist at CDFG Menlo Park.

[9] This fishery description was provided by Marija Vojkovich, biologist at CDFG Santa Barbara.

attract spawning aggregations of squid. The use of lights to attract squid has never been restricted in southern California but in the Monterey fishery it has been allowed and disallowed several times in the past 15 years. Presently, lights are allowed statewide. The use of lights has not been regulated thus far due to biological concerns only sociological.

Regulations: All vessels participating in the squid fishery must have a permit. The fishery north of Point Conception is open from noon Sunday to noon Friday each week. The squid fishery in southern California is open each day of the week, however, the Fish and Game Commission recently adopted a regulation restricting the squid fishing days to those in effect north of Point Conception. It also adopted a mandatory logbook program for both fishing and lighting vessels.

Management type: This fishery came under more strict regulatory control by the Department of Fish and Game in January 1998 although it is a monitored fishery in the Pacific Fishery Management Council's newly adopted Coastal Pelagic Species Plan. A state management plan is to be completed by April 1, 2001. Limited entry, use of lights, closed areas, gear restrictions, and seasons are management options to be considered in the development of the management plan.

Comments: The squid fishery operates primarily at night and uses lights. Encounters between the fishery and pilot whales, pinnipeds, and birds have been documented. Seal bombs are used regularly. Lethal and nonlethal interaction rates are unknown. The fishery grew rapidly from 1993/94 until 1997/98 due to increased market demands from Asian countries especially China. That market demand has been eliminated and many vessels are left without a buyer for their squid. Consequently, fishing effort has slowed considerably.

Category III, WA Willapa Bay salmon drift gillnet fishery.

Number of permit holders: The total number of permit holders for this fishery in 1995 and 1996 was 300 but this number has declined in subsequent years. In 1997 there were 264 total permits and 243 in 1998.

Number of active permit holders: The number of active permit holders is assumed to be equal to or less than the number of permits eligible to fish in a given year. The number of permits renewed and eligible to fish in 1996 was 300 but declined to 224 in 1997 and 196 permits were renewed for 1998. The 1996-98 counts do not include permits held on waivers for those years, but do include permits that were eligible to fish at some point during the year and subsequently entered into a buyback program. The number of permits issued for this fishery has been reduced through a combination of State and federal permit buyback programs. Vessels permitted to fish in the Willapa Bay are also permitted to fish in the lower Columbia River drift gillnet fishery.

Total effort: Effort in this fishery is regulated through area and species openings. The fishery was observed in 1992 and 1993 when fishery opening were greater than in recent years. In 1992 and 1993 there were 42 and 19 days of open fishing time during the summer "dip-in" fishery. The "dip-in" fishery was closed in 1994 through 1999. Available openings have also declined in the fall chinook/coho fisheries. In 1992/93 respectively there were 44 and 78 days of available fishing time. There were 43, 45, 22 and 16.5 available open fishing days during 1995 through 1998.

Geographic range: This fishery includes all inland marine waters of Willapa Bay. The waters of the Bay are further divided into smaller statistical catch areas.

Seasons: Seasonal openings coincide with local salmon run timing and fish abundance.

Gear type: Fishing gear used in this fishery is a drift gillnet of single web construction, not exceeding 250 fathoms in length, with a minimum stretched mesh size ranging upward from 5 inches depending on target salmon species. The gear is commonly set during periods of low and high slack tides. It is the intention of the fisher to keep the net off the bottom. The vessel is attached to one end of the net and drifts with the net. The entire net is periodically retrieved onto the vessel and catch is removed. Drift times vary depending on fishing area, tidal condition, and catch.

Appendix 1. Fishery Descriptions

Regulations: This fishery is a limited entry fishery with seasonal openings and gear restrictions.

Management type: The salmon drift gillnet fishery is managed by the Washington Department of Fish and Wildlife.

Comments: Observers were placed onboard vessels in this fishery to monitor marine mammal interactions in the early 1980s and in 1990-93. Five incidentally taken harbor seals were recovered by observers in the fishery from 1991through 1993 (3 in '92 and 2 in '93). Two incidentally taken northern elephant seals were recovered by observers from the fishery in 1991 but no takes of this species were observed. The summer fishery (July- August) in Willapa Bay has been closed since it was last observed in 1993 and available fishing time declined from 1996 through 1998.

Category III, WA Grays Harbor salmon drift gillnet fishery.

Number of permit holders: This commercial drift gillnet fishery does not include Treaty Indian salmon gillnet fishing. The total number of permit holders for this commercial fishery in 1995 and 1996 was 117 but this number has declined in subsequent years. In 1997 there were 101 total permits and 87 in 1998.

Number of active permit holders: The number of active permit holders is assumed to be equal to or less than the number of permits eligible to fish in a given year. The number of permits renewed and eligible to fish in 1996 was 117 but declined to 79 in 1997 and 59 permits were renewed for 1998. The 1996-98 counts do not include permits held on waivers for those years but do include permits that were eligible to fish at some point during the year and subsequently entered a buyback program. The number of permits issued for this fishery has been reduced through a combination of State and federal permit buyback programs. Vessels permitted to fish in Grays Harbor are also permitted to fish in the lower Columbia River salmon drift gillnet fishery.

Total effort: Effort in this fishery is regulated through area and species openings. The fishery was observed in 1992 and 1993 when fishery openings were greater than in recent years. In 1992 and 1993 there were 42 and 19 days of open fishing time during the summer "dip-in" fishery. The "dip-in" fishery was closed in 1994 through 1999. Available openings have also declined in the fall chinook/coho fisheries. There were 11, 17.5, 9 and 5 available open fishing days during the 1995 through 1998 fall season.

Geographic range: Effort in this fishery includes all marine waters of Grays Harbor. The waters are further divided into smaller statistical catch areas.

Seasons: This fishery is subject to seasonal openings which coincide with local salmon run timing and fish abundance.

Gear type: Fishing gear used in this fishery is a drift gillnet of single web construction, not exceeding 250 fathoms in length, with a minimum stretched mesh size ranging of 5 inches depending on target salmon species. The gear is commonly set during periods of low and high slack tides and retrieved periodically by the tending vessel. It is the intention of the fisher to keep the net off the bottom. The vessel is attached to one end of the net and drifts with the net. The entire net is periodically retrieved onto the vessel and catch is removed. Drift times vary depending on fishing area, tidal condition, and catch

Regulations: The fishery is a limited entry fishery with seasonal openings and gear restrictions.

Management type: The salmon drift gillnet fishery is managed by the Washington Department of Fish and Wildlife.

Comments: Observers were placed onboard vessels in this fishery to monitor marine mammal interactions in the early 1980s and in 1990-93. Incidental take of harbor seals was observed during the fishery in 1992 and 1993. In 1992, one harbor seal was observed entangled dead during the summer fishery and one additional seal was observed entangled during the fall fishery but it escaped uninjured. In 1993, one harbor seal was observed entangled dead and one

additional seal was recovered by observers during the summer fishery. The summer fishery (July-August) in Grays Harbor has been closed since it was last observed in 1993. Available fishing time in the fall chinook fisheries declined from 1996 through 1998.

Category III, WA, OR lower Columbia River salmon drift gillnet fishery.

Number of permit holders: The total number of permit holders was 856 (344 from Oregon and 512 from Washington) when the fishery was last observed in 1993. In 1995 through 1998 the number of permits was 747, 693, 675 and 620 respectively. The number of permits issued for this fishery by Washington has been reduced through a combination of State and federal buy-back programs. This reduction is reflected in the overall decline in the total number of permits.

Number of active permit holders: The number of active permits is a subset of the total permits issued for the fishery. For example, in 1995, 110 vessels (of the 747 vessels holding permits) landed fish in the mainstem fishery.

Total effort: Effort in this fishery is regulated through species related seasonal openings and gear restrictions. The fishery was observed in 1991, 1992 and 1993 during several seasons of the year. The winter seasons (openings) for 1991 through 1993 totaled 13, 9.5, and 6 days respectively. The winter season has subsequently been reduced to remnant levels to protect upriver ESA listed salmon stocks. In 1995 there was no winter salmon season, in 1996 the fishery was open for 1 day. In 1997 and 1998 the season was shifted to earlier in the year and gear restrictions were imposed to target primarily sturgeon. The fall fishery in the mainstem was also observed 1992 and 1993 as was the Young's Bay terminal fishery in 1993, however, no marine mammal mortalities were observed during these fisheries. The fall mainstem fishery openings varied from 1 day in 1995 to just under 19.5 days in 1997 and 6 days in 1998. The fall Youngs Bay terminal fishery fluctuated between 60 and 70 days for the 1995 through 1998 period which was similar to the fishery during the period observed.

Geographic range: This fishery occurs in the main stem of the Columbia river from the mouth at the Pacific Ocean upstream to river mile 140 near the Bonneville Dam. The lower Columbia is further subdivided into smaller statistical catch areas which can be regulated independently.

Seasons: This fishery is subject to season and statistical area openings which are designed to coincide with run timing of harvestable salmon runs while protecting weak salmon stocks and those listed under the Endangered Species Act. In recent years, early spring (winter) fisheries have been sharply curtailed for the protection of listed salmon species. In 1994, for example, the spring fishery was open for only three days with approximately 1900 fish landed. In 1995 the spring fishery was closed and in 1996 the fishery was open for one day but fishing effort was minimal owing to severe flooding. Only 100 fish were landed during the one day in 1996.

Gear type: Typical gear used in this fishery is a gillnet of single web construction, not exceeding 250 fathoms in length, with a minimum stretched mesh size ranging upwards from 5 inches depending on target salmon species. The gear is commonly set during periods of low and high slack tides. It is the intention of the fisher to keep the net off the bottom. The vessel is attached to one end of the net and drifts with the net. The entire net is periodically retrieved onto the vessel and catch is removed. Drift times vary depending on fishing area, tidal condition, and catch

Regulations: The fishery is a limited entry fishery with seasonal openings, area closures, and gear restrictions.

Management type: The lower Columbia River salmon drift gillnet fishery is managed jointly by the Washington Department of Fish and Wildlife and the Oregon Department of Fish and Wildlife.

Comments: Observers were placed onboard vessels in this fishery to monitor marine mammal interactions in the early 1980s and in 1990-93. Incidental takes of harbor seal and California sea lion were documented, but only during the winter seasons (which have been reduced dramatically in recent years to protect ESA listed salmon) . No mortalities

were observed during the fall fisheries.

Category III, WA, OR salmon net pens.

Number of permit holders: There were 12 commercial salmon net pen ("grow out") facilities licensed in Washington in 1998. There are no commercial salmon net pen or aquiculture facilities currently licensed in Oregon. Non-commercial salmon enhancement pens are not included in the list of commercial fisheries.

Number of active permit holders: Twelve salmon net pen facilities in Washington.

Total effort: The 12 licensed facilities on Washington operate year-round.

Geographic range: In Washington, net pens are found in protected waters in the Straits (Port Angeles), northern Puget Sound (in the San Juan Island area) as well as in Puget Sound south of Admirality Inlet. There are currently no commercial salmon pens in Oregon.

Seasons: Salmon net pens operate year-round.

Gear type: Net pens are large net impoundments suspended below a floating dock-like structure. The floating docks are anchored to the bottom and may also support guard (predator) net systems. Multiple pens are commonly rafted together and the entire facility is positioned in an area with adequate tidal flow to maintain water quality.

Regulations: Specific regulations unknown.

Management type: In Washington, the salmon net pen fishery is managed by the Washington Department of Natural Resources through Aquatic Lands Permits as well as the Washington Department of Fish and Wildlife.

Comments: Salmon net pen operations have not been monitored by NMFS for marine mammal interactions, however, incidental takes of California sea lions and harbor seals have been reported.

Category III, WA, OR, CA groundfish trawl.

Approximate number of vessels/persons: In 1998, approximately 332 vessels used bottom and mid-water trawl gear to harvest Pacific coast groundfish. This is down from 383 vessels in 1995. Groundfish trawl vessels harvest a variety of species including Pacific whiting (hake), flatfish, sablefish, lingcod, and rockfish. This commercial fishery does not include Treaty Indian fishing for groundfish.

All observed incidental marine mammal takes have occurred in the mid-water trawl fishery for Pacific whiting. The annual whiting allocation is divided between vessels that harvest and process catch at sea and those that harvest and deliver catch to shore-based processing facilities. At least one NMFS-trained observer is placed on board each at-sea processing vessel to provide comprehensive data on total catch, including marine mammal takes. Whiting vessels that deliver to shore-based processors are issued Exempted Fishing Permits that requires the entire catch to be delivered unsorted to processing facilities where State technicians have the opportunity to sample. In 1998, 13% of the whiting deliveries landed at shore-based processors were monitored. The following is a description of the commercial whiting fishery.

Number of permit holders/active permit holders: A license limitation ("limited entry") program has been in effect in the Pacific coast groundfish fishery since 1994. Non-tribal trawl vessels that harvest groundfish are required to possess a limited entry permit to operate in the fishery. Any vessel with a federal limited entry trawl permit may fish for whiting, but the number of vessels that do is smaller than the number of permits. In 1998, approximately 61 limited entry vessels,

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7 catcher/processors and 50 catcher vessels delivering to shoreside and mothership processors, made commercial landings of whiting during the regular season. In addition, 6 unpermitted mothership processors received unsorted whiting catch.

Total effort: The whiting allocation continues to be fully utilized. From 1997 to 1999 the annual allocation was 232,000 mt/year, this is an increase over the 1996 allocation of 212,000 mt and the 1995 allocation of 178,400 mt. In 1998, motherships vessels received 50,087 mt of whiting in 17 days, catcher/processors took 70,365 mt of whiting in 54 days and shore-based processors received 87,862 mt of whiting over a 196 day period.

Geographic range: The fishery extends from northern California (about 40E30' N. latitude) to the U.S.-Canada border. Pacific whiting migrate from south to north during the fishing season, so effort in the south usually occurs earlier than in the north.

Seasons: From 1997 to 1999, season start dates have remained unchanged. The shore-based season in most of the Eureka area (between 42^{O}- $40^{O}30'$ N latitude) began on April 1, the fishery south of $40^{O}30'$ N latitude opened April 15, and the fishery north of 42^{O} N latitude started on June 15. In 1998, the primary season for the shore-based fleet closed on October 13, 1998. The primary seasons for the mothership and catcher/processor sectors began May 15, north of 42^{0} N. lat. In 1998, the mothership fishery closed on May 31, the catcher/processor fishery closed on August 7.

Gear type: The Pacific whiting trawl fishery is conducted with mid-water trawl gear with a minimum mesh size of 3 inches throughout the net.

Regulations/Management type: This fishery is managed through federal regulations by the Pacific Fishery Management Council under the Groundfish Fishery Management Plan.

Comments: Since 1991, incidental takes of Steller sea lions, Pacific white-sided dolphin, Dall's porpoise, California sea lion, harbor seal, and northern elephant seal have been documented in the whiting fishery. From 1996 to 1999 , 2 Steller sea lions, 2 northern elephant seals, 2 California sea lions, 3 Pacific white-sided dolphins, and 6 Dall's porpoise were reported by observers in the at-sea processing fleet. Between 1996 and 1999, one incidental take of a harbor seal was documented in the shore-based fleet.

Category III, Hawaii gillnet fishery.[10]

Number of active permit holders: In 1997 there were 129 active commercial fishers. In 1995 there were approximately 115.

Total effort: In 1997 there were 2,109 trips for a total catch of 864,194 pounds with 792,210 pounds sold. This fishery operates in nearshore and coastal pelagic regions.

Seasons: This fishery operates year-round with the exception of Juvenile big-eyed scad less than 8.5 inches which cannot be taken from July through October.

Gear type: Gillnets of stretched mesh greater than 2 inches and stretched mesh size greater than 2.75 inches for stationary gillnets. Stationary nets must be inspected every 2 hours and total soak time cannot exceed four hours in the same location. Additional mesh restrictions are in place for taking the big-eyed scad.

[10]Descriptions of Hawaii State managed fisheries provided by William Devick, State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources, Honolulu Hawaii.

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Regulations: Gear and season restrictions (see above).

Management type: Managed by the State of Hawaii Division of Aquatic Resources.

Comments: The principle catches include reef fishes and big-eyed scad (akule) and mackerel scad (opelu). Interactions have been documented with bottlenose dolphin and spinner dolphin.

Category III, Hawaii swordfish, tuna, billfish, mahi mahi, wahoo, and oceanic shark longline/set line fishery.[11]

Number of permit holders: There are 164 permits under a (1994) federal limited entry program.

Number of active permit holders: In 1998 there were 114 active fishing vessels. For the years 1991-1997 the average number of active fishing vessels was 118 vessels, declining from the peak in 1991 of 141 vessels.

Total effort: For the years 1994-1998, there were on average 1,120 (min=1,100,max=1,140) trips made, 11,700 (sd=609) days of fishing effort and 14.7 million (sd=1.97 million) hooks set. The number of hooks set has been steadily increasing since 1994 and has peaked in 1998 with 17.4 million hooks set. Most of the effort occurred outside the and the main Hawaiian Islands' EEZ with less effort in the EEZ's of US possessions, with the exception of Kingman Reef and Palmyra Atoll. Fleet landings for 1998 totaled 28.6 million pounds ($46.6 million), one of the highest years on record.

Geographic range: This fishery encompasses a huge geographic range extending North-South from 40° N to the equator and East-West from Kure Atoll to as far as 135° W. Fishing for broadbills generally occurs north of Hawaii, (as much as 2,000 miles from Honolulu), whereas fishing for tunas occurs around the Main Hawaiian Islands (MHI) and south of the Hawaiian Islands.

Seasons: This fishery operates year-round. Effort is generally lower in the third quarter of the year.

Gear type: For broadbills, typically a 16-48 km monofilament line having as many as 700-1,000 branch lines (9-18 m long), one in five attached with a "lightstick" (to attract squid, which in turn attracts the broadbills) placed about 76 cm above the hook (usually baited with squid) is set in the evening and retrieved early the next morning. For tunas, a 32 km long main line, set during the day, is suspended from buoys and 1,000-1,400 dropper lines are attached to the main line each with a hook (usually baited with whole fish).

Regulations: Effort is required to be outside of 50 nautical miles from the entire Northwestern Hawaiian islands (NWHI) because of possible protected species (monk seal) interactions. Several 25-75 mile closed areas also exist around the MHI to prevent gear conflicts with smaller fishing vessels.

Management type: Federal limited access program.

Comments: This Hawaii longline fishery is active year-round and targets swordfish and tuna, other species are caught incidentally. A small number of marine mammal interactions with bottlenose dolphin and false killer whale, humpback whale, Risso's dolphin, and bottlenose dolphin have been documented. In 1998 interaction with one humpback whale was reported (NMFS logbook data) by a fisher. This may have been a result of the whale getting fouled in longline gear. No interactions with monk seals have been reported. Due to interactions with protected species, especially turtles, this

[11] Ito, Russell Y. and Walter A. Machado. 1999. Annual report of the Hawaii-based longline fishery for 1998. Administrative Report H-99-06, available from NMFS, Southwest Fisheries Science Center, La Jolla, CA 92038.

fishery has been observed since February 24, 1994 with a coverage of less than 5%.

Category III, Hawaii lobster trap fishery.[10] [12] [13]
Note: The portion of this fishery managed by the State of Hawaii and operating in the MHI is about 1% of the size (total pounds of lobster caught) of the federally managed fishery operating primarily in the NWHI. The description that follows refers to the NWHI fishery unless stated otherwise.

Number of permit holders: There are 15 permit holders under a (1991) federal limited access program.

Number of active permit holders: In 1998 and 1999 there were 5 and 6 vessels that participated respectively. In the MHI there were 5 active fishers in 1997.

Total effort: The number of trap hauls for 1999 is not available at this time. However, the majority of the effort took place in the 4 harvest guideline areas; Necker Bank, Gardner Pinnacles and Maro Reef, with the remaining effort spread out over 10 unique areas. In 1998 171,000 trap hauls were made by the 5 vessels during 9 trips and in 1997 a total of 177,700 hauls were made. In the MHI 19 trips were made in 1997.

Geographic range: Lobster permits allow fishing operations in the US EEZ from 3 to 200 nmi offshore American Samoa, Guam and Hawaii (including the EEZ areas of the NWHI and MHI). However, no vessels have operated in the EEZ's of American Samoa or Guam since 1983.

Seasons: This fishery operates under a seasonal harvest guideline system opening on July 1. The season ends once the harvest guideline is met, but no later than December 31. In 1998, the harvest guideline was divided into the 4 areas mentioned above with total lobster catch set at (in thousands) 70, 20, 80, and 116, respectively. Area closure occurs once an area's harvest guideline is met. In the MHI, open season is from September through April.

Gear type: One string consists of approximately 100 Fathom-plus plastic lobster traps. About 10 such strings are pulled and set each day. Since 1987 escape vents that allow small lobsters to escape from the trap have been mandatory. In 1996, the fishery became "retain all", i.e. there are no size limits or prohibitions on the retention of berried female lobsters. The entry-way of the lobster trap must be less than 6.5 inches to prevent monk seals from getting their heads stuck in the trap. In the MHI, rigid trap materials must have a dimension greater than 1 inch by 2 inches, with the trap not exceeding 10 feet by six feet.

Regulations: Season, gear and quota restrictions (see above) for the NWHI were formulated by the Western Pacific Regional Fishery Management Council and implemented by NMFS. The MHI fishery is managed by the State of Hawaii, Division of Aquatic Resources with season and gear restrictions (see above).

Management type: Limited access program with bank specific quotas and closures. In the MHI, open access.

Comments: The NWHI fishery targets the red spiny lobster and the common slipper lobster. The ridgeback slipper lobster is also taken. Protected species of concern include monk seals (mentioned above) and turtles. There have been no interactions with these species since 1995 but they have been seen in the vicinity of the fishing gear.

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[12]Kawamoto, K. and Samuel G. Pooley. 1999. Draft Annual report of the 1998 western pacific lobster fishery.

[13]Kawamoto, K. 1999. Summary of the 1999 NWHI Lobster Fishing Season. NMFS Honolulu Laboratory.

Appendix 1. Fishery Descriptions

Category III, Hawaii inshore handline fishery.

In 1997 a total 750 fishers made 8,526 fishing trips in the main Hawaiian Islands and caught 531,449 pounds and sold 475,562 pounds for an ex-vessel landing value of $1,010,758. This fishery occurs in nearshore and coastal pelagic regions. The principal catches include reef fishes and big-eyed scad (akule) and mackerel scad (opelu). In 1995 approximately 650 fishers were active. Interactions have been documented for bottlenose dolphin.

Category III, Hawaii deep sea bottomfish handline and jig fishery.
Note: There are two commercial bottomfish fisheries in Hawaii: a distant water Northwestern Hawaiian Islands (NWHI) limited entry fishery under federal jurisdiction and the main Hawaiian Islands bottomfish fishery primarily under the State of Hawaii jurisdiction.

Number of permit holders: The main Hawaiian Islands fishery is open access with close to 2,000 bottomfish vessels registered with the State of Hawaii, whereas the NWHI is restricted to a maximum of 17 vessels.

Number of active permit holders: In 1997 in the MHI a total of 750 fishers were active. The NWHI are divided into the Mau Zone (closer to MHI) and the Hoomalu Zone. The Hoomalu Zone is a limited entry zone with 6 vessels participating in 1998, 7 vessels fished the Mau Zone in the same year. Restrictions on new entry into the Mau Zone were implemented in 1998.

Total effort: In 1998 in the MHI approximately 8,500 trips were made with a total catch of 424,000 pounds for an ex-vessel landing value of $1,336,000. This fishery occurs primarily in offshore banks and pinnacles. In the NWHI 332,000 pounds ($894,000) were caught in 1998, below average since 1990.

Seasons: Year round.

Gear type: This fishery is a hook-and-line fishery that takes place in deep water. In the NWHI fishery, vessels are 30 ft or greater and conduct trips of about 10 days. In the MHI the vessels are smaller than 30 ft and trips last from 1 to 3 days.

Regulations: In the MHI, the sale of snappers (opakapaka, onaga and uku) and jacks less than one pound is prohibited. In June of 1998, Hawaii Division of Aquatic Resources (HDAR) closed 19 areas to bottomfishing and regulations pertaining to seven species (onaga, opakapaka, ehu, kalekale, gindai, hapuupuu and lehi) were enacted.

Management type: The MHI is managed by the HDAR with catch, gear and area restrictions (see above) but no permit limits. The NWHI is a limited access federal program.

Comments: The deep-slope bottomfish fishery in Hawaii concentrates on species of eteline snappers, carangids, and a single species of grouper concentrated at depths of 30-150 fathoms. These fish have been fished on a subsistence basis since ancient times and commercially for at least 90 years. NMFS is considering the possibility of re-categorizing the NWHI bottomfish fishery from Category III to Category II due to concerns for potential interactions between bottomfish fishing vessels and Hawaiian monk seals, although there were none observed during 26 NWHI bottomfish trips during 1990-1993, and none reported. On 12 of the 26 trips, bottlenose dolphins have been observed steeling fish from the lines, but not hookings or entanglements occurred. Effort in this fishery increases significantly around the Christmas season because a target species, a true snapper, is typically sought for cultural festivities.[11] No data is collected for recreational or subsistence fishermen, but their MHI catch is estimated to be about equal to the MHI commercial catch.

Category III, Hawaii tuna handline and jig fishery.

In 1997 a total of 543 fishers made 6,627 trips in the MHI and caught 2,014,656 pounds and sold 1,958,759 pounds for

an ex-vessel value of $3,788,391. This fishery occurs around offshore fish aggregating devices and mid-ocean seamounts and pinnacles. The principal catches are small to medium sized bigeye, yellowfin and albacore tuna. There are several types of handline methods in the Hawaiian fisheries. Baited lines with chum are used in day fishing operations (palu-ahi), another version uses squid as bait during night operations (ika-shibi), and an operation called "danglers" uses multiple lines with artificial lures suspended or dangled over the water. Interactions have been documented for rough-toothed dolphin, bottlenose dolphin, and Hawaiian monk seal.

Appendix 1. Fishery Descriptions

Table 1. The number of animals injured (I) and killed (K) reported to the Marine Mammal Authorization Program (MMAP) compared with data reported from the NMFS Observer Program for two California gillnet fisheries for the years 1996-1998.

Category I, CA/OR thresher shark/swordfish drift gillnet fishery

	1996				1997				1998			
	MMAP		NMFS		MMAP		NMFS		MMAP		NMFS	
Species	I	K	I	K	I	K	I	K	I	K	I	K
Minke whale	0	1	0	1	0	0	0	0	0	0	0	0
Sperm whale	1	0	1	0	0	0	0	0	0	1	0	1
Gray Whale	0	0	0	0	0	0	0	0	0	1	0	1
Pacific white-sided dolphin	2	2	0	3	1	3	0	3	0	0	0	0
Common dolphin	19	6	0	28	1	20	1	24	1	6	0	9
Northern right-whale dolphin	0	1	0	5	0	4	0	5	0	0	0	0
Dall's porpoise	0	1	0	2	0	0	0	4	0	0	0	0
Unidentified Small cetacean	0	4	0	0	0	0	0	0	0	0	0	0
California sea lion	0	6	0	4	4	15	2	37	0	19	0	23
Steller sea lion	0	0	0	0	0	0	0	0	0	1	0	0
Northern elephant seal	0	5	0	5	0	6	1	8	0	0	0	4
Total Occurrences Reported	22	26	1	48	6	48	4	81	1	28	0	38

Category I, CA large mesh (>3.5in) set gillnet fisheries (angel shark/halibut and other species)

	1996				1997				1998			
	MMAP		NMFS		MMAP		NMFS		MMAP		NMFS	
Species	I	K	I	K	I	K	I	K	I	K	I	K
Common dolphin	0	1	Not Observed		0	3	Not Observed		0	2	Not Observed	
California sea lion	0	10			0	4			0	2		
Harbor seal	0	2			0	0			0	0		
Total Occurrences Reported	0	13			0	7			0	4		

Appendix 1. Fishery Descriptions

Table 2. Strandings reported to the NMFS Marine Mammal Stranding Network 1996-1998.

Species	1996				1997				1998			
	CA		OR/WA		CA		OR/WA		CA		OR/WA	
	n	%HR (#)	n	% HR (#)	n	%HR (#)	n	% HR (#)	n	%HR (#)	n	% HR (#)
Harbor Porpoise	18	16.7 (3)	0	0 (0)	26	0 (0)	3	0 (0)	37	10.8(4)	25	0 (0)
Dall's Porpoise	2	0 (0)	8	0 (0)	4	0 (0)	10	0 (0)	2	0 (0)	2	0 (0)
Pac. White-sided Dolphin	1	0 (0)	0	0 (0)	5	20.0(1)	0	0 (0)	5	0 (0)	1	0 (0)
Risso's Dolphin	1	0 (0)	0	0 (0)	2	0 (0)	0	0 (0)	3	0 (0)	0	0 (0)
Bottlenose Dolphin	3	0 (0)	0	0 (0)	3	0 (0)	0	0 (0)	4	0 (0)	0	0 (0)
Common Dolphin	30	0 (0)	0	0 (0)	15	6.7(1)	0	0 (0)	35	2.9(1)	0	0 (0)
Striped Dolphin	0	0(0)	0	0 (0)	1	0 (0)	1	0 (0)	2	0 (0)	0	0 (0)
N. Right Whale Dolphin	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	1	0 (0)	0	0 (0)
Rough-toothed Dolphin	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	1	0 (0)	0	0 (0)
Killer Whale	1	0 (0)	0	0 (0)	1	0 (0)	0	0 (0)	0	0 (0)	1	0 (0)
Short-finned Pilot Whale	0	0 (0)	1	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)
Stejneger's Beaked Whale	0	0 (0)	1	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)
Cuvier's Beaked Whale	1	0 (0)	0	0 (0)	2	0 (0)	0	0 (0)	2	0 (0)	1	0 (0)
Peruvian Beaked Whale	0	0(0)	0	0 (0)	0	0 (0)	0	0 (0)	1	100(1)	0	0 (0)
Unident. Beaked Whale	1	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)
Pygmy Sperm Whale	2	0 (0)	1	0 (0)	0	0 (0)	0	0 (0)	6	0 (0)	0	0 (0)
Sperm Whale	0	0(0)	0	0 (0)	1	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)
Gray Whale	13	38.5 (5)	4	0 (0)	10	60.0(6)	3	0 (0)	3	100(3)	4	0 (0)
Minke Whale	1	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	1	0 (0)	1	0 (0)
Blue Whale	1	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)
Fin Whale	1	100 (1)	0	0 (0)	1	100(1)	1	0 (0)	1	0 (0)	0	0 (0)
Humpback Whale	1	0 (0)	0	0 (0)	3	33.3(1)	0	0 (0)	2	0 (0)	2	0 (0)
Unidentified Cetacean	2	0 (0)	0	0 (0)	3	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)
Unidentified Porpoise	0	0 (0)	2	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)	0	0 (0)
Unidentified Dolphin	8	0 (0)	0	0 (0)	16	0 (0)	1	0 (0)	12	0 (0)	5	0 (0)
Unidentified Whale	1	0 (0)	1	0 (0)	7	14.3(1)	1	100(1)	2	0 (0)	0	0 (0)
Unident. Balaenopterid	1	0 (0)	0	0 (0)	1	100(1)	0	0 (0)	0	0 (0)	1	0 (0)
Northern Fur Seal	12	0 (0)	0	0 (0)	50	0(0)	1	0 (0)	21	0 (0)	1	0 (0)
Guadalupe Fur Seal	2	0 (0)	0	0 (0)	2	0(0)	0	0 (0)	3	0 (0)	0	0 (0)
Steller (Nthn) Sea Lion	10	0 (0)	2	0 (0)	7	0(0)	3	33.3(1)	10	20.0(2)	7	0 (0)
California Sea Lion	724	14.6 (106)	30	23.3 (7)	1262	10.6(134)	10	30.0(3)	2576	77.3(199)	75	12.0(9)
Unidentified Sea Lion	0	0 (0)	23	4.76 (1)	0	0(0)	0	0 (0)	0	0 (0)	0	0 (0)
Harbor Seal	302	4.30 (13)	109	19.3 (21)	297	5.7(17)	127	9.4(12)	313	6.7(21)	121	5.8(7)
Northern Elephant Seal	240	2.08 (5)	2	50 (1)	241	0.4(1)	0	0 (0)	409	1.5(6)	24	0 (0)
Unidentified Seal	0	0 (0)	21	0 (0)	0	0(0)	0	0 (0)	0	0 (0)	5	0 (0)
Unidentified Pinniped	159	0 (0)	1	0 (0)	202	0(0)	113	0 (0)	236	0 (0)	88	0 (0)
Totals for Cetaceans	89	10.1 (9)	18	0 (0)	101	11.9(12)	20	5.0(1)	120	6.1(9)	43	0 (0)
Totals for Pinnipeds	1449	8.63(125)	188	16.0 (30)	2061	152	254	6.3(16)	3568	228	321	5.0(16)

Appendix 1. Fishery Descriptions

Table 3. Characteristics of Category I Gillnet Fisheries in California.

Fishery	Species	Mesh Size	Water Depth	Set Duration	Deployment	Miscellaneous
Category I CA/OR Thresher Shark/Swordfish drift gillnet fishery	**Swordfish/ Shark**	**14" - 22"**	**Ranges from 50fms to 2500fms**	**Typically 8-15 hrs.**	**Drift Net Only**	**Nets 300-1000 fms; 1000fms common; Other species caught: opah, louvar, tuna, thresher, blue shark, mako shark.**
Category I CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fisheries	**Halibut/angel shark**	**8.5"**	**< 40 fms**	**24 hrs**	**Set Net**	
	Barracuda	**3.5"**	**--**	**< 12 hrs**	**Drift Net**	**April - July**
	Leopard Shark	**7.0" - 9.0"**	**< 50 fms**	**--**	**–**	**Fished similar to halibut. Few boats target leopard shark.**
	Perch/Croaker	**3.5" - 4.0"**	**< 15 - 20 fms**	**< 24 hrs**	**Set Net**	**Few boats target these species.**
	Rockfish	**4.5" - 7.5"**	**> 50 fms**	**12 - 18 hrs**	**Set Net**	**Net lengths 250 - 1000 fms. Soupfin shark is a major incidental catch in rockfish fisheries.**
	Soupfin Shark	**6.0" - 8.5"**	**> 30 fms**	**24 hrs**	**Set Net**	**Few boats target soupfin shark.**
	White Sea bass/ Yellowtail	**Usually 6.5" 6.0" - 7.0"**	**Usually 10 - 50 fms or Shallow 3 - 4 fms**	**8 - 24 hrs.**	**Mostly Drift Net**	**White sea bass predominant target species. Nets 200 - 1000 fms.**
	Miscellaneous Shark	**6.0" - 14"**	**< 40 fms**	**8 - 24 hrs**	**Drift, some Set Net**	**Species include thresher and swell sharks.**

Additional Notes:

1. In southern California, gillnets are generally prohibited within three miles of shore.
2. In central California, there are 30 or 40 fathom closures depending on area.
3. In northern California, set gillnets are not allowed.

Appendix 1. Fishery Descriptions

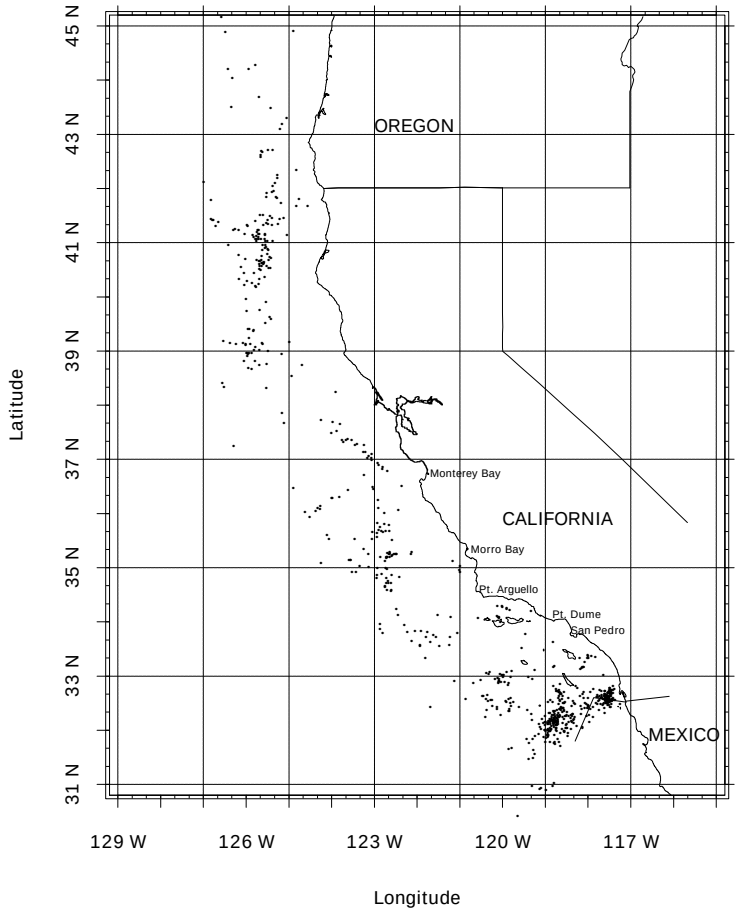

Figure 1. Observed set locations of the drift-net fishery during 1994.

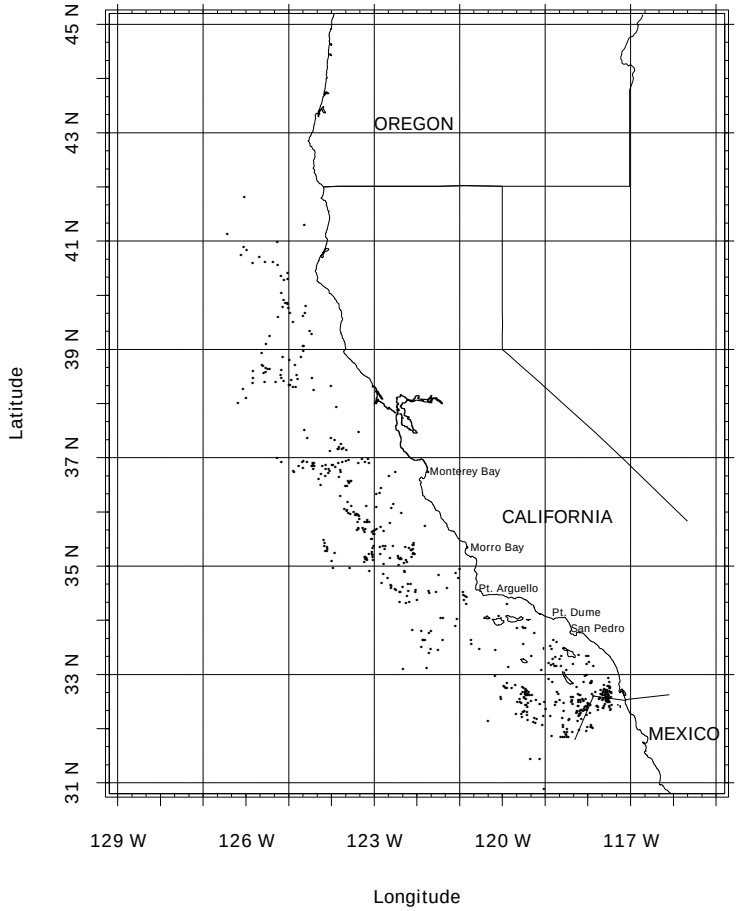

Figure 2. Observed set locations of the drift-net fishery during 1995

Appendix 1. Fishery Descriptions

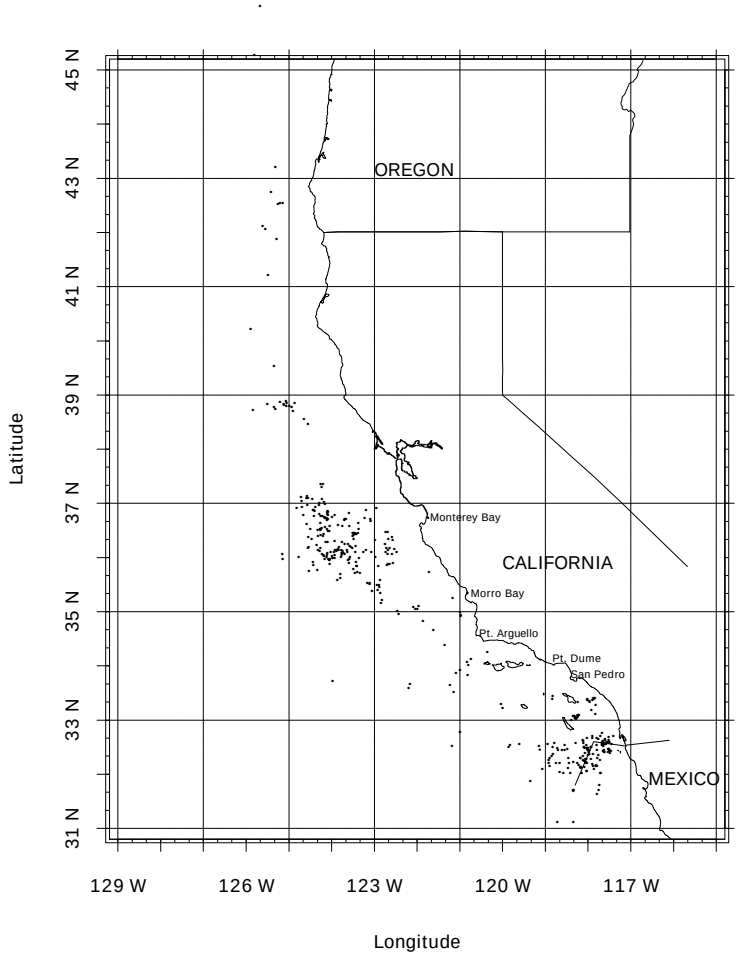

Figure 3. Observed set locations of the drift-net fishery during 1996.

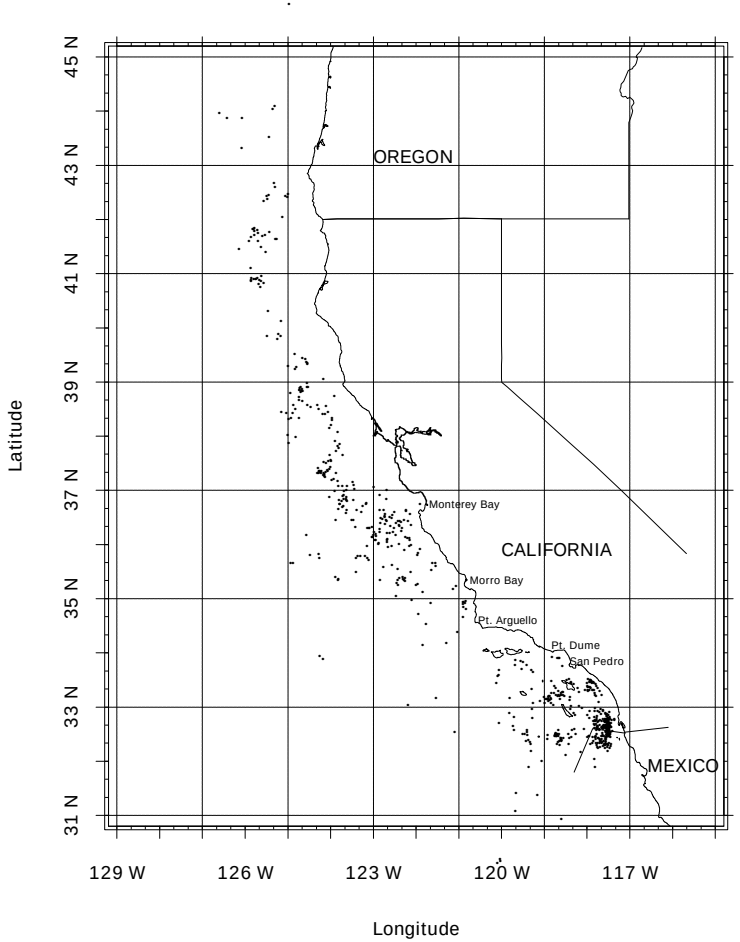

Figure 4. Observed set locations of the drift-net fishery during 1997.

Appendix 1. Fishery Descriptions

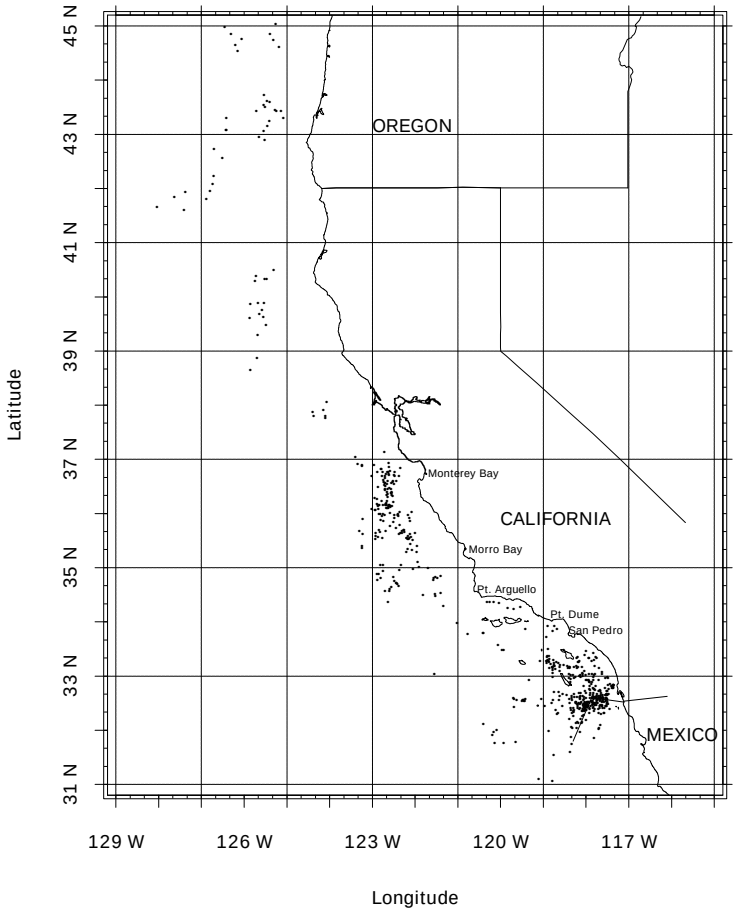

Figure 5. Observed set locations of the drift-net fishery during 1998.

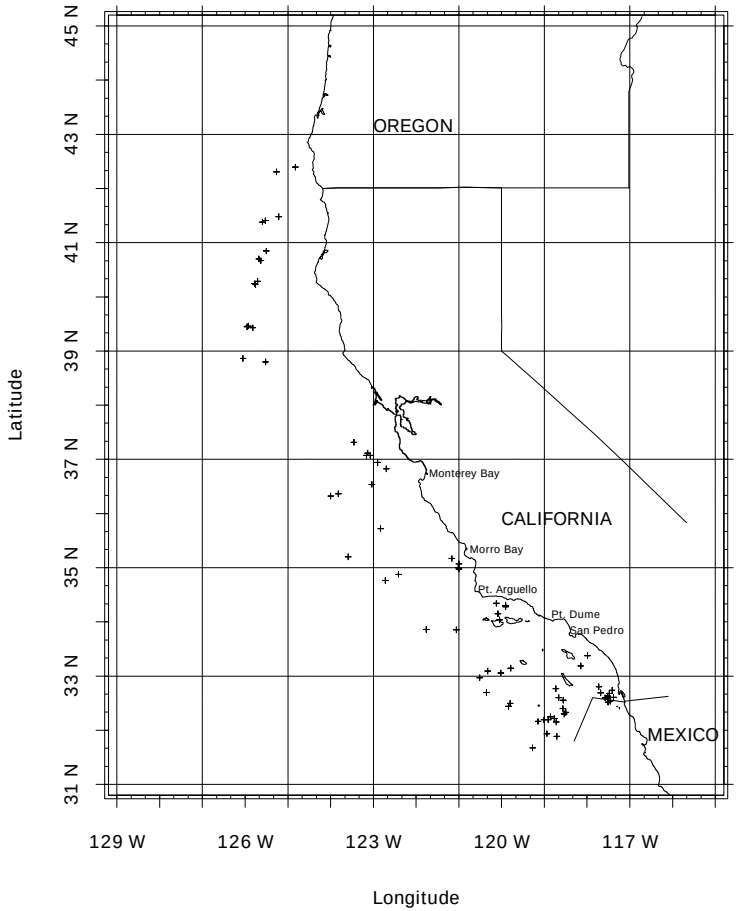

Figure 6. Observed locations of marine mammal entanglements in the drift-net fishery during 1994.

Appendix 1. Fishery Descriptions

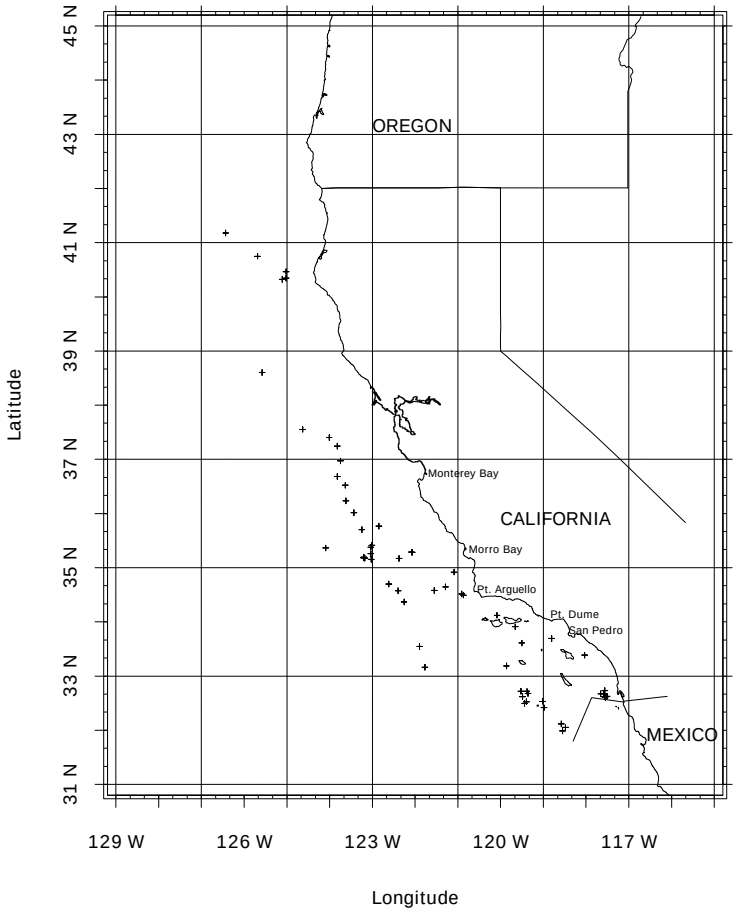

Figure 7. Observed locations of marine mammal entanglements in the drift-net fishery during 1995.

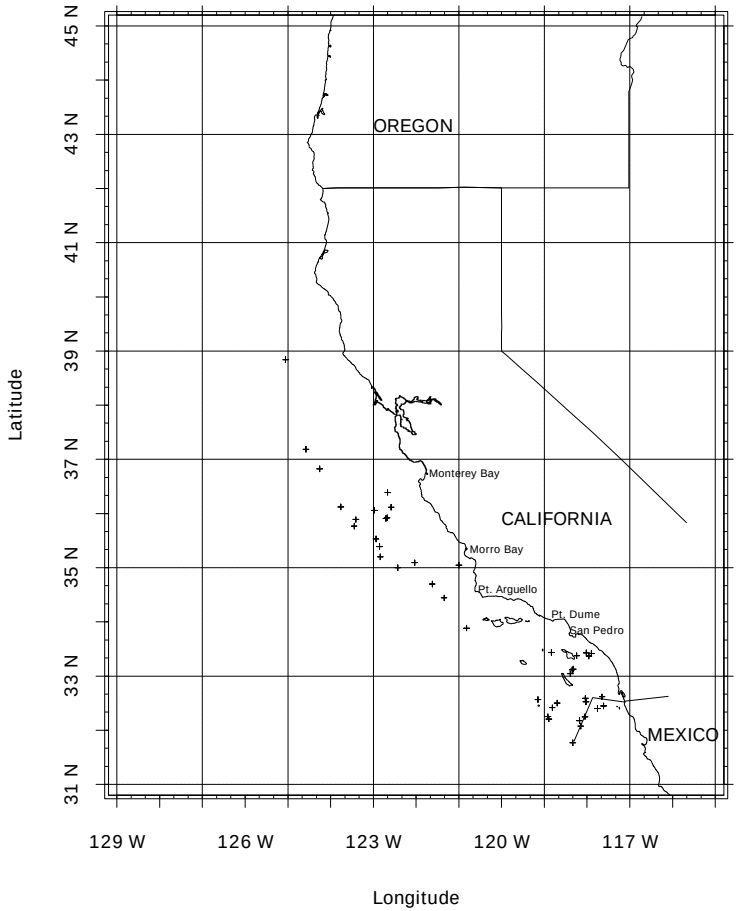

Figure 8. Observed locations of marine mammal entanglements in the drift-net fishery during 1996.

Appendix 1. Fishery Descriptions

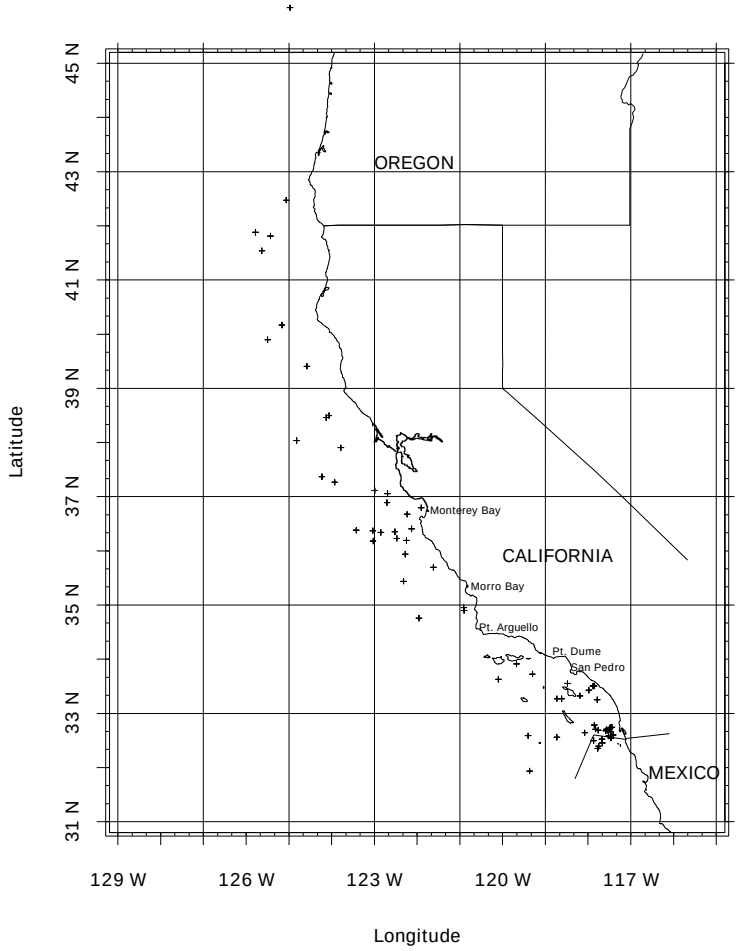

Figure 9. Observed locations of marine mammal entanglements in the drift-net fishery during 1997.

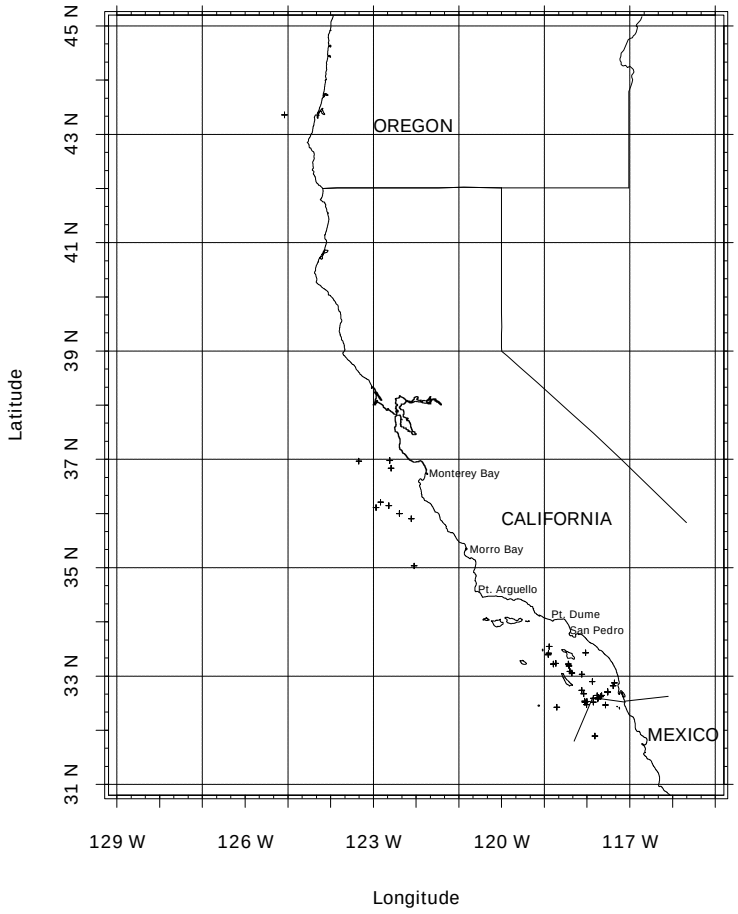

Figure 10. Observed locations of marine mammal entanglements in the drift-net fishery during 1998.

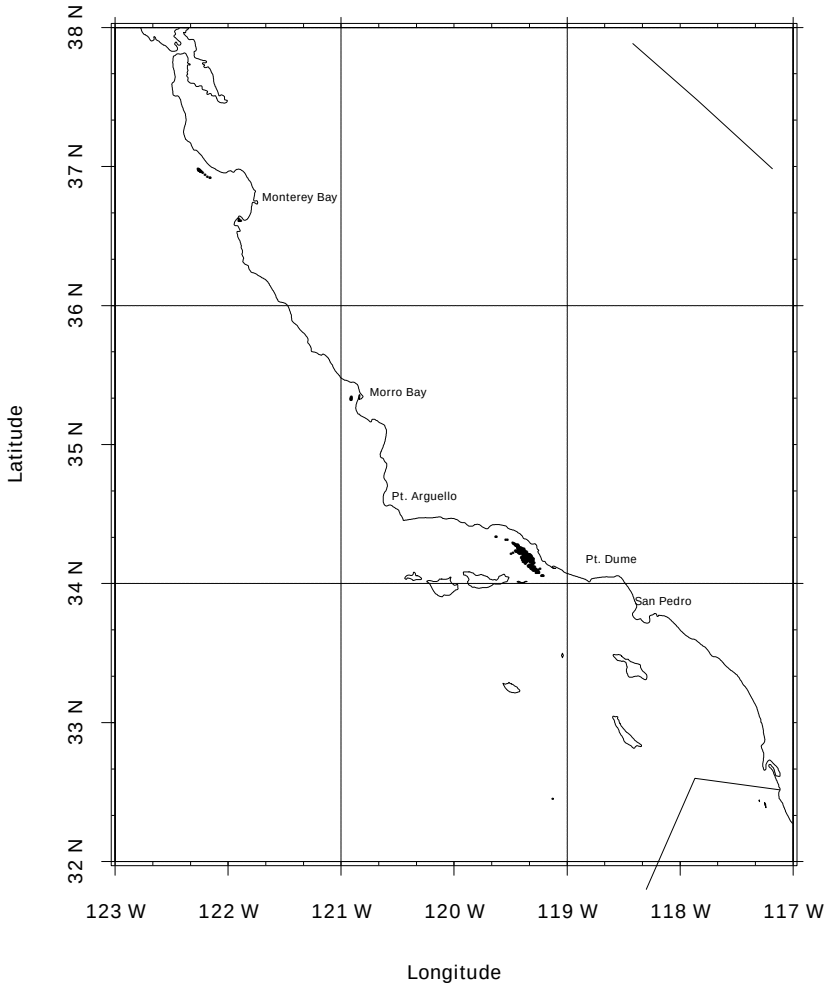

Figure 11. Observed set locations of the set gillnet fishery during 1994.

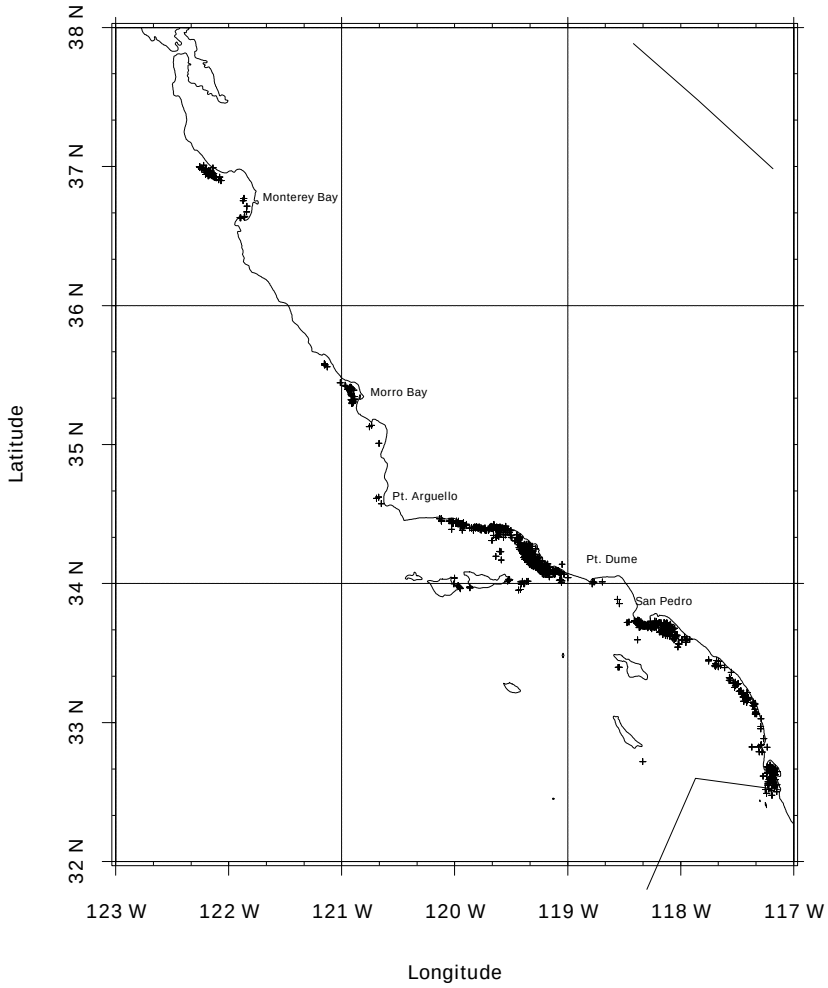

Figure 12. Observed marine mammal entanglements in the set gillnet fishery, 1990-1994.

Appendix 1. Fishery Descriptions

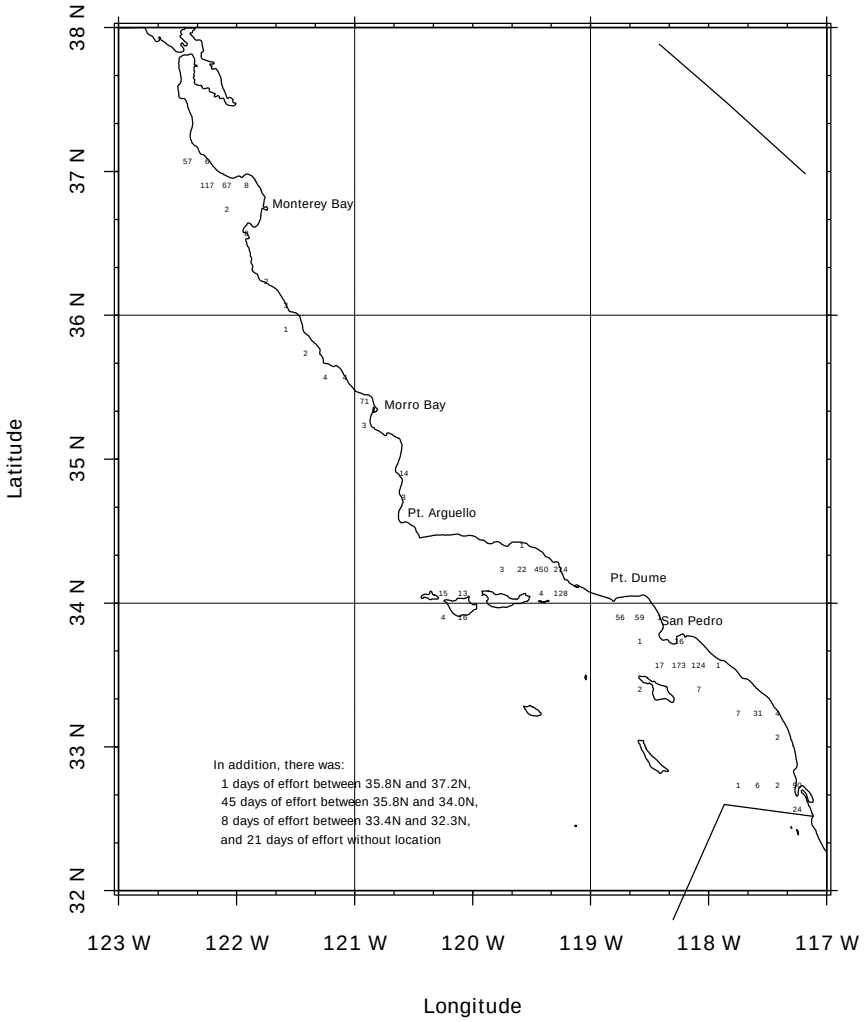

Figure 13. Set gillnet fishery estimated days of fishing effort by CDFG block for 1994.

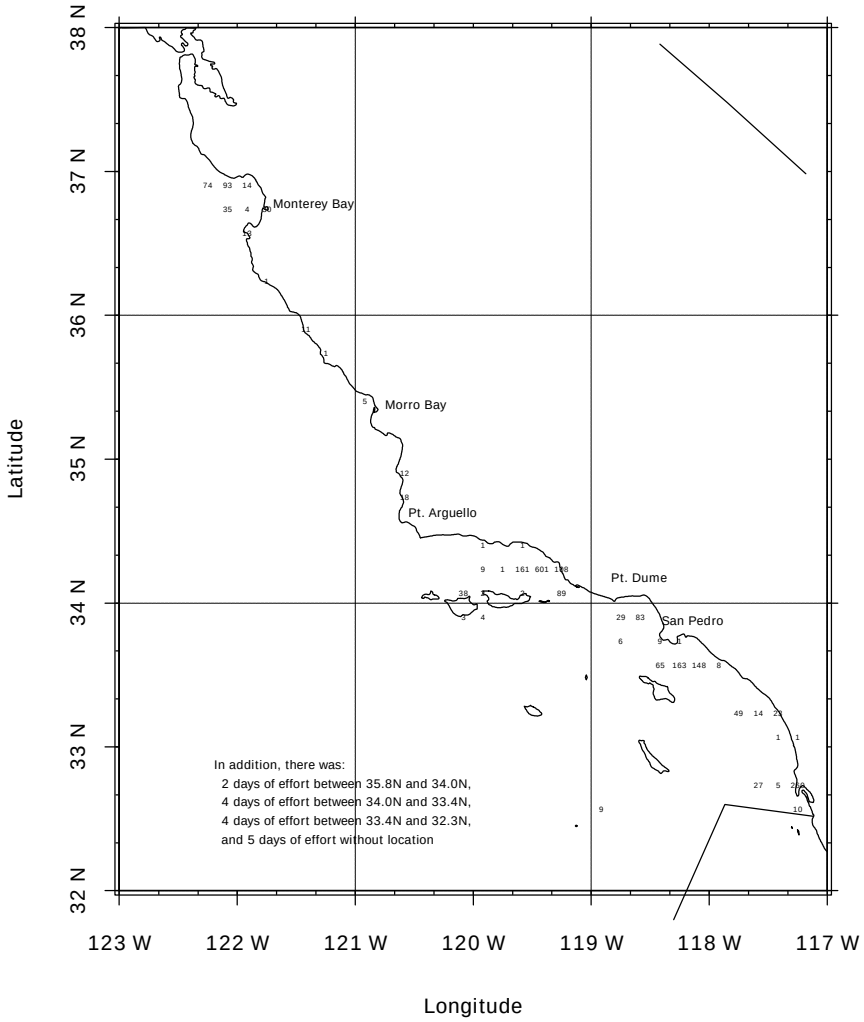

Figure 14. Set gillnet fishery estimated days of fishing effort by CDFG block for 1995.

Appendix 1. Fishery Descriptions

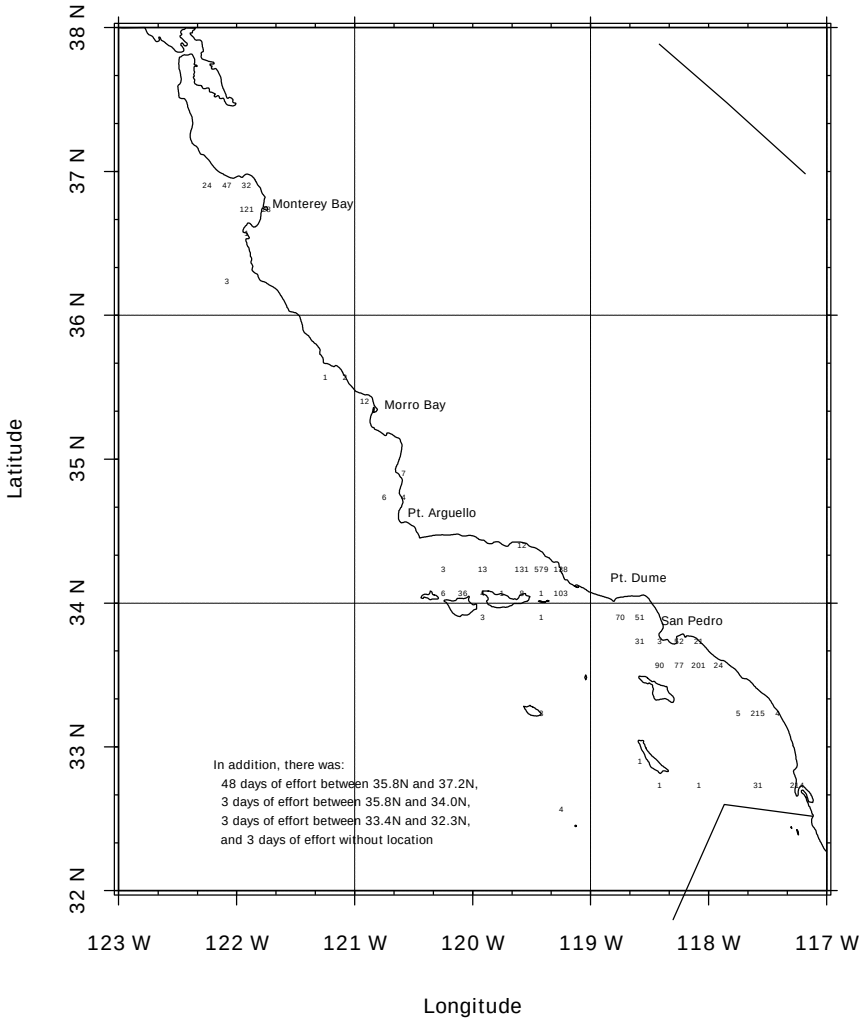

Figure 15. Set gillnet fishery estimated days of fishing effort by CDFG block for 1996.

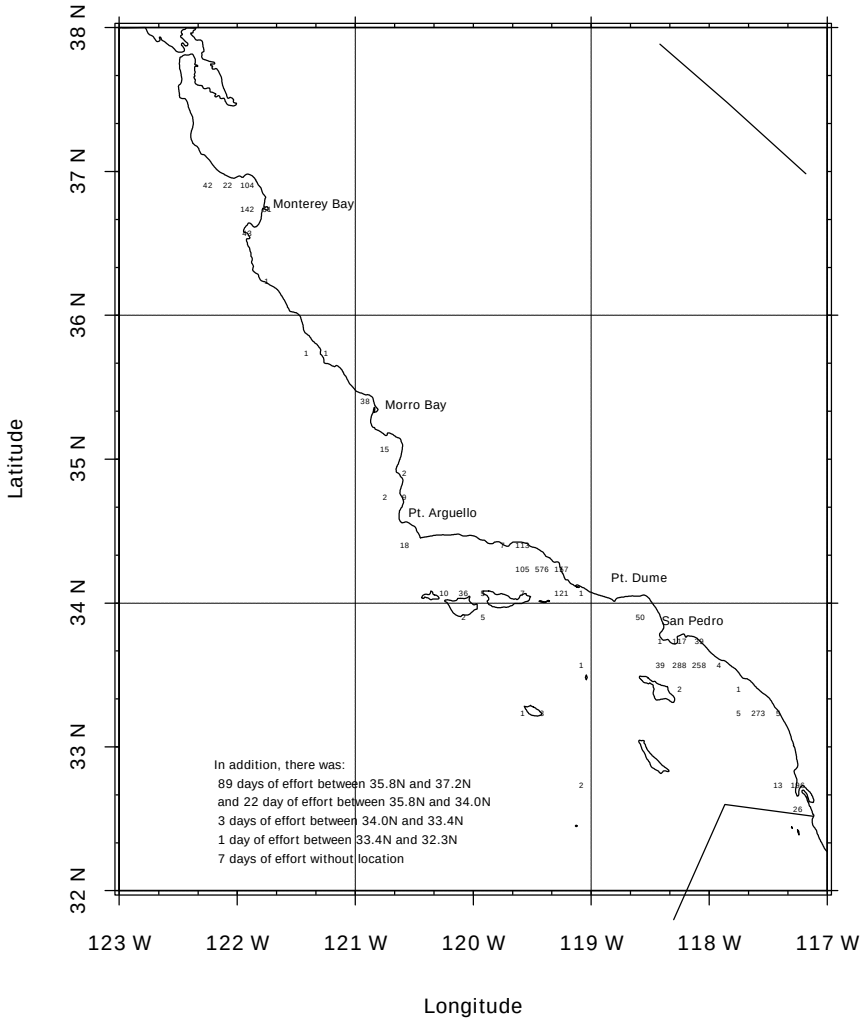

Figure 16. Set gillnet fishery estimated days of fishing effort by CDFG block for 1997.

Appendix 1. Fishery Descriptions

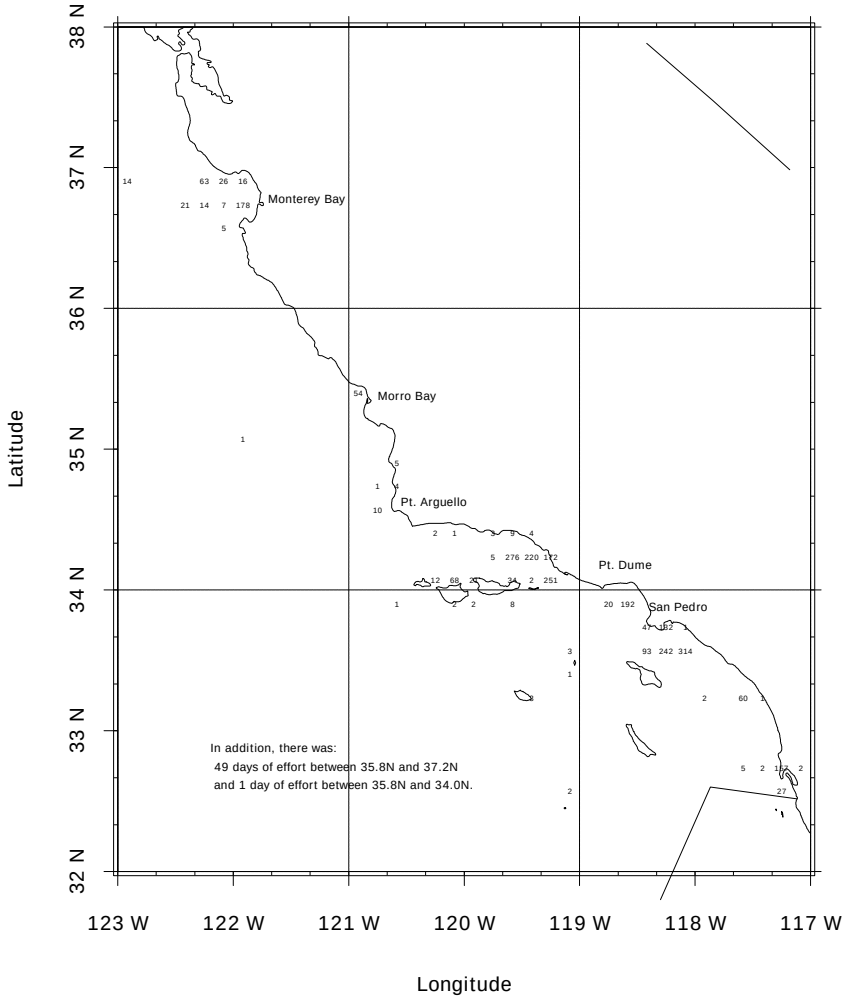

Figure 17. Set gillnet fishery estimated days of fishing effort by CDFG block for 1998.

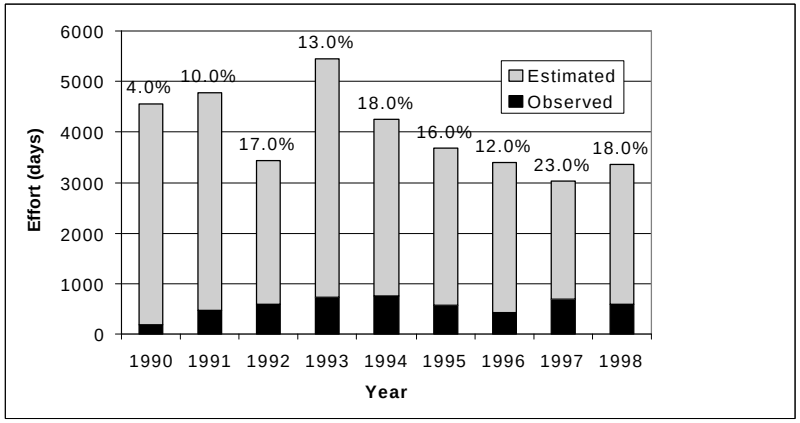

Figure 18. Estimated and observed drift-net fishery days of effort. Percent coverage is indicated above bars.

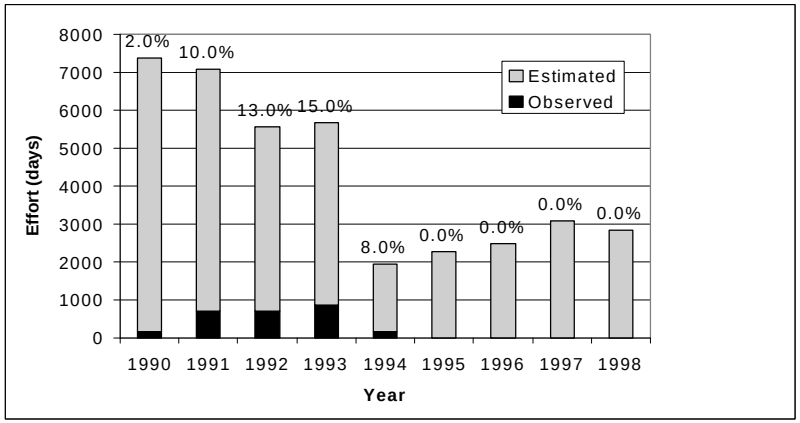

Figure 19. Estimated and observed set-net fishery days of effort. Percent coverage is indicated above bars.

Appendix 2. Cetacean Survey Effort

This appendix presents a summary of survey effort from which cetacean sighting locations were taken and plotted in stock assessment reports.

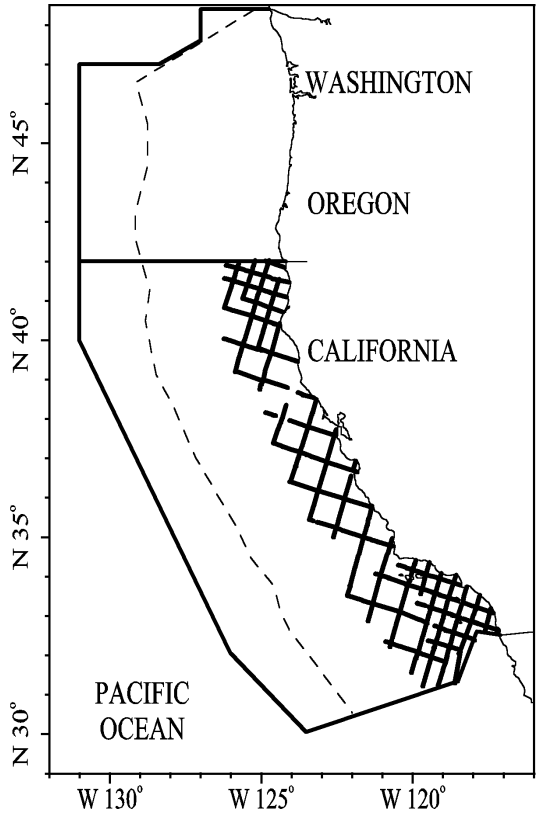

Figure 1. Transect lines completed during a 1991 aerial survey of California waters. (Forney et al. 1995)

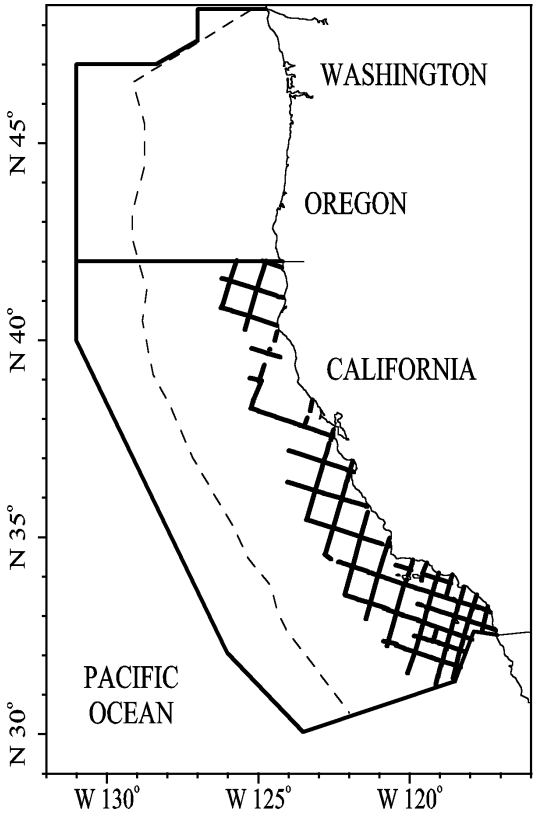

Figure 2. Transect lines completed during a 1992 aerial survey of California waters (Forney et al. 1995).

Appendix 2. Cetacean Survey Effort

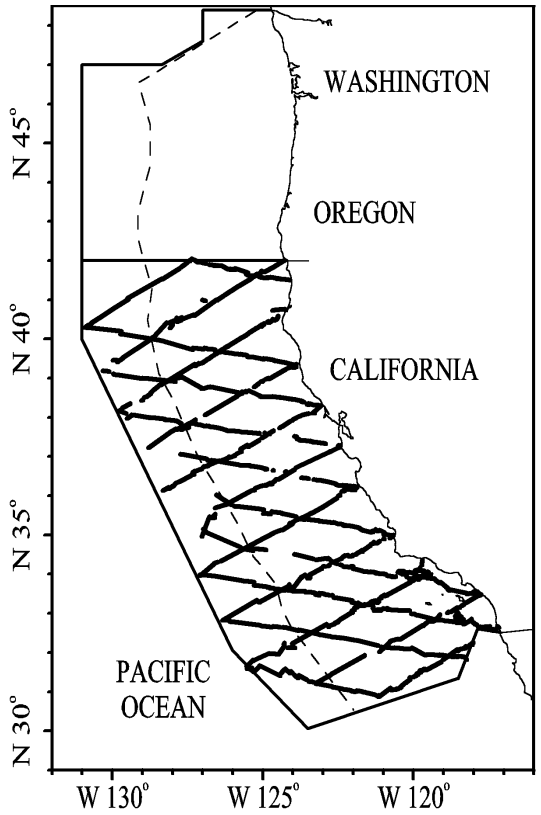

Figure 3. Transect lines completed during a 1991 vessel survey of California waters (Barlow 1995).

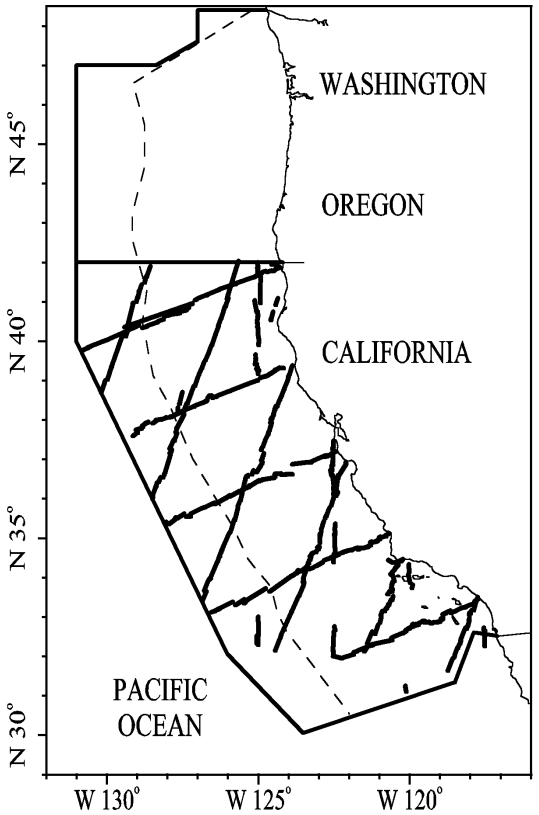

Figure 4. Transect lines completed during a 1993 vessel survey of California waters (Mangels and Gerrodette 1994)

Appendix 2. Cetacean Survey Effort

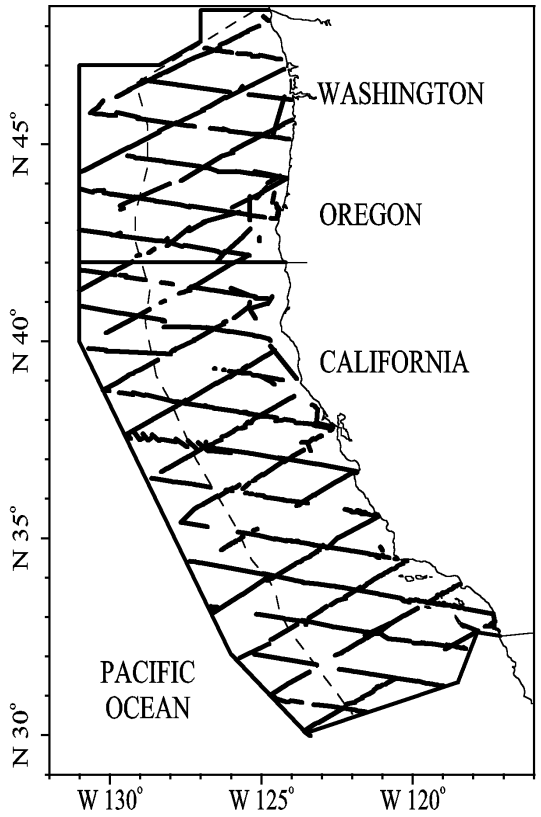

Figure 5. Transcribe lines completed during a 1996 vessel survey of California, Oregon, and Washington waters (Barlow 1997; Von Saunder and Barlow 1999).

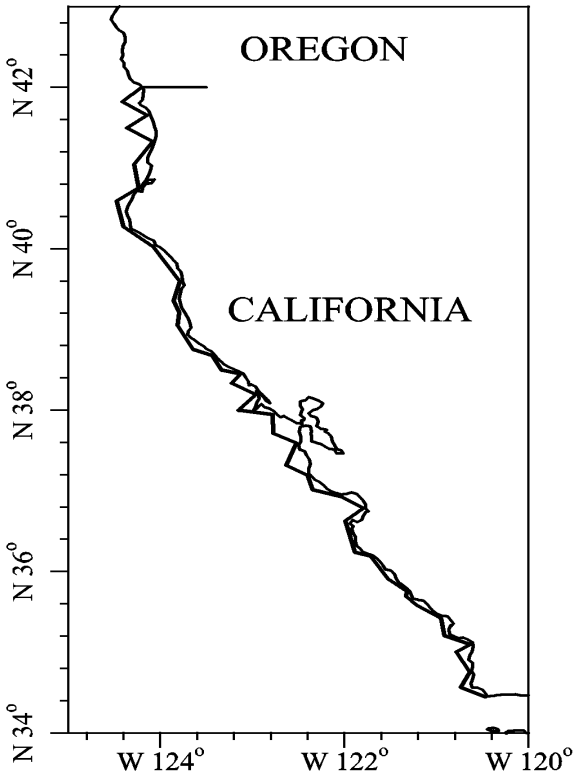

Figure 6. Transect lines surveyed during 1989-97 aerial surveys of central and northern California (Forney et al. 1991; Forney 1995).

Appendix 2. Cetacean Survey Effort

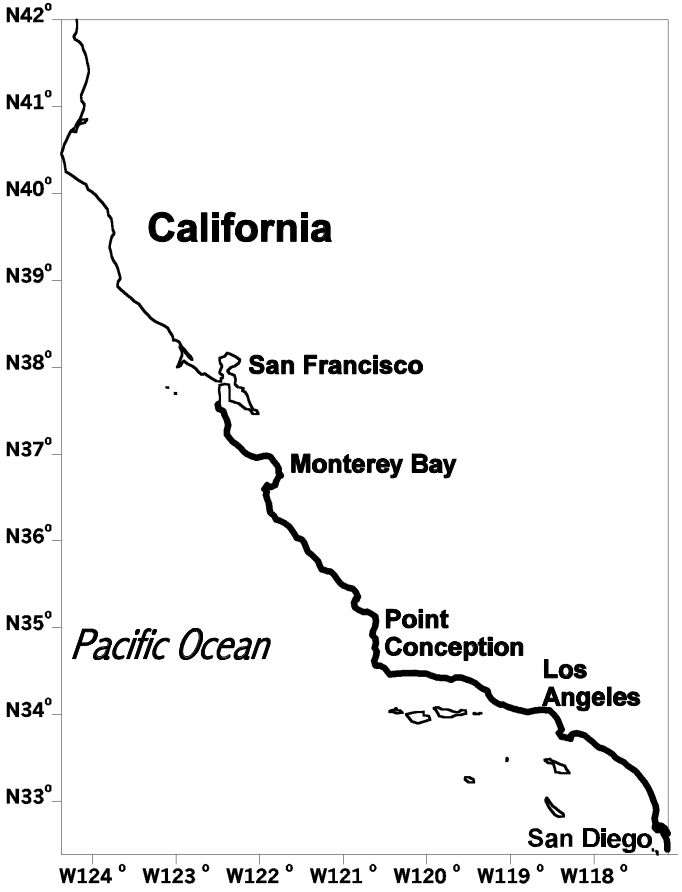

Figure 7. Coastline section (in bold) surveyed during 1990-1999 aerial surveys in southern and central California (Carretta et al. 1998).

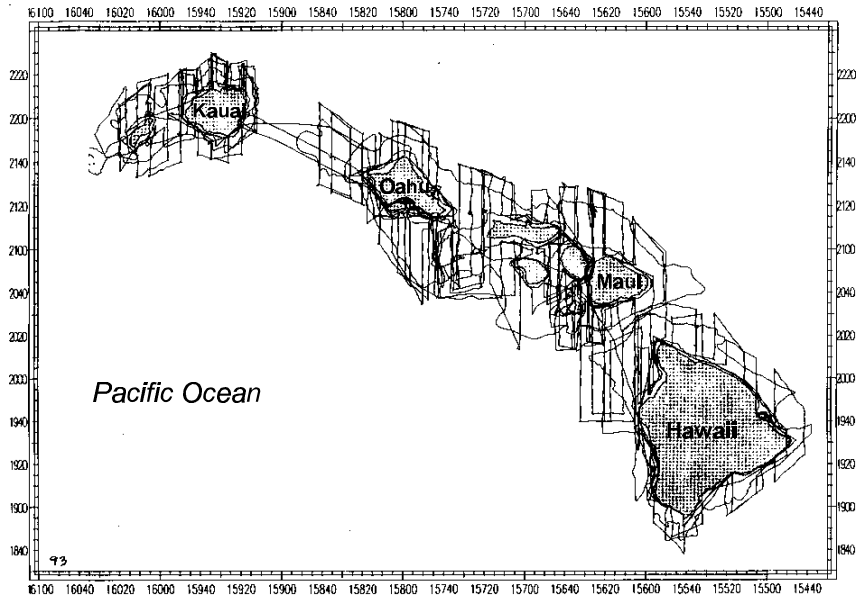

Figure 8. Transect lines completed during 1993 aerial surveys of the main Hawaiian islands (Mobley et al. 1999).

Appendix 2. Cetacean Survey Effort

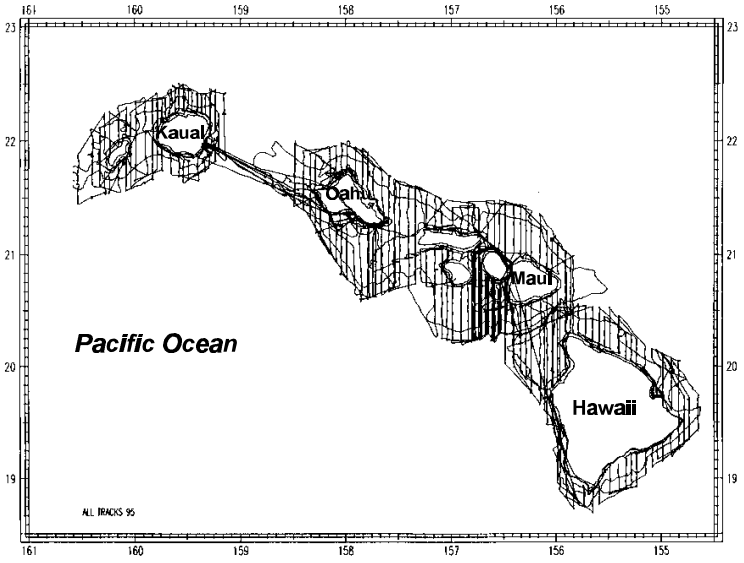

Figure 9. Transect lines completed during 1995 aerial surveys of the main Hawaiian Islands (Mobley et al. 1999).

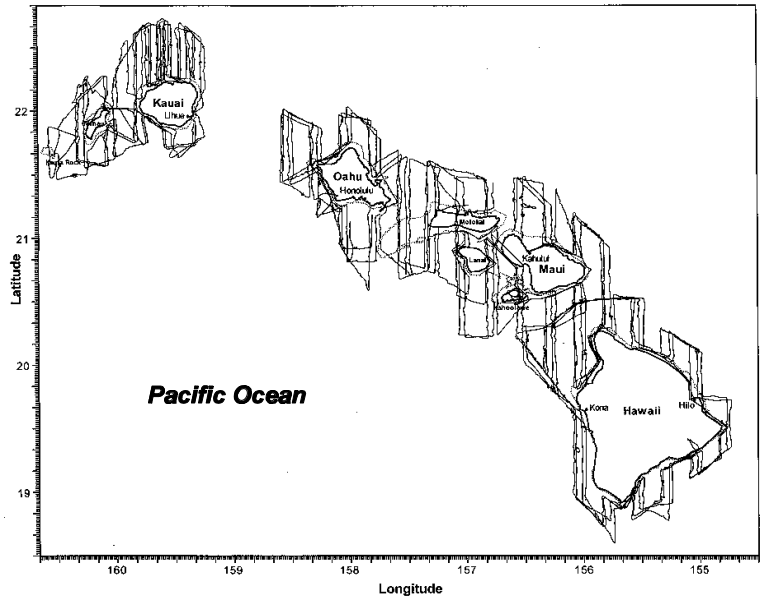

Figure 10. Transect lines completed during 1998 aerial surveys of the main Hawaiian Islands (Mobley et al. 1999).

Appendix 2. Cetacean survey effort

References

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. Admin. Rep. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25 pp.

Carretta, J.V., K.A. Forney, and J.L. Laake. 1998. Abundance of southern California coastal bottlenose dolphins estimated from tandem aerial surveys. Mar. Mamm. Sci. 14(4):655-675.

Forney, K.A., D. Hanan, and J. Barlow. 1991. Detecting trends in harbor porpoise abundance from aerial surveys using analysis of covariance. Fish. Bull. 89:367-377.

Forney, K.A. 1995. A decline in the abundance of harbor porpoise, Phocoena phocoena, in nearshore waters off California, 1986-93. Fish. Bull. 93(4):741-748.

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(4):15-26.

Mobley, J.R., R.A. Grotefendt, P.H. Forestell, and A. Frankel. 1999. Results of aerial surveys of marine mammals in the major Hawaiian Islands (1993-98): Report to the Acoustic Thermometry of Ocean Climate Marine Mammal Research Program (ATOC MMRP). University of Hawaii-West Oahu 96-129 Ala Ike, Pearl City, HI 96782. 39 pp.

Mangels, K.F. and T. Gerrodette. 1994. Report of cetacean sightings during a marine mammal survey in the eastern Pacific Ocean and the Gulf of California aboard the NOAA ships McArthur and David Starr Jordan July 28 - November 6, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-221. 88 pp.

Von Saunder, A. and J. Barlow. 1999. A report of the Oregon, California, and Washington line-transect experiment (ORCAWALE) conducted in west coast waters during summer/fall 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-264. 49 pp.

APPENDIX 3 (revised 10/31/2002)

Stocks for which new assessment reports were written in 2002 are indicated by **bold** font.

SUMMARY OF 2002 PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS (FOR STOCKS UNDER NMFS JURISDICTION)

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fish. Mortality + Serious Injury	Strategic Status
California sea lion	U.S.	PAC	SWC	109,854	0.12	1.0	6,591	1,352	1,208	N
Harbor Seal	California	PAC	SWC	27,962	0.12	1.0	1,678	≥ 714	666	N
Harbor Seal	**Oregon/ Washington Coast**	**PAC**	**AKC**	**22,380**	**0.12**	**1.0**	**1,343**	**≥ 17**	**≥ 16**	**N**
Harbor Seal	**Washington Inland Waters**	**PAC**	**AKC**	**12,844**	**0.12**	**1.0**	**771**	**≥ 34**	**≥ 30**	**N**
Northern Elephant Seal	**California breeding**	**PAC**	**SWC**	**60,547**	**0.083**	**1.0**	**2,513**	**≥ 88**	**≥ 86**	**N**
Guadalupe Fur Seal	Mexico to California	PAC	SWC	3,028	0.137	0.5	104	0.0	0.0	Y
Northern Fur Seal	San Miguel Island	PAC	AKC	2,336	0.086	1.0	100	0.0	0.0	N
Monk seal	**Hawaii**	**PAC**	**SWC**	**1,437**	**0.07**	**0.1**	**5.0**	**n/a**	**n/a**	**Y**
Harbor porpoise	**Morro Bay**	**PAC**	**SWC**	**669**	**0.04**	**0.5**	**7**	**3.2**	**3.2**	**N**
Harbor porpoise	**Monterey Bay**	**PAC**	**SWC**	**1,151**	**0.04**	**0.5**	**11**	**80**	**80**	**Y**
Harbor porpoise	**San Francisco-Russian River**	**PAC**	**SWC**	**4,858**	**0.04**	**0.5**	**49**	**≥ 0.4**	**≥ 0.4**	**N**
Harbor porpoise	**Northern CA/Southern OR**	**PAC**	**SWC**	**12,940**	**0.04**	**1.0**	**259**	**≥ 0**	**≥ 0**	**N**
Harbor porpoise	**Oregon/ Washington Coast**	**PAC**	**AKC**	**28,967**	**0.04**	**0.5**	**290**	**9**	**9**	**N**
Harbor porpoise	**Washington Inland Waters**	**PAC**	**AKC**	**2,545**	**0.04**	**0.4**	**20**	**15**	**15**	**N**
Dall's Porpoise	California/ Oregon/ Washington	PAC	SWC	81,866	0.04	0.45	737	12	12	N
Pacific White-sided Dolphin	California/ Oregon/ Washington	PAC	SWC	17,475	0.04	0.45	157	≥ 6.8	≥ 6.8	N

APPENDIX 3 (revised 10/31/2002)
Stocks for which new assessment reports were written in 2002 are indicated by **bold** font.

SUMMARY OF 2002 PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS (FOR STOCKS UNDER NMFS JURISDICTION)

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fish. Mortality + Serious Injury	Strategic Status
Risso's Dolphin	California/ Oregon/ Washington	PAC	SWC	13,079	0.04	0.4	105	5.5	5.5	N
Bottlenose Dolphin	California coastal	PAC	SWC	186	0.04	0.5	1.9	0	0	N
Bottlenose Dolphin	California/ Oregon/ Washington Offshore	PAC	SWC	850	0.04	0.5	8.5	0	0	N
Striped Dolphin	California/ Oregon/ Washington	PAC	SWC	17,995	0.04	0.5	180	0	0	N
Common dolphin, short-beaked	California/ Oregon/ Washington	PAC	SWC	318,795	0.04	0.5	3,188	79	79	N
Common dolphin, long-beaked	California	PAC	SWC	27,739	0.04	0.45	250	14	14	N
Northern right-whale dolphin	California/ Oregon/ Washington	PAC	SWC	10,060	0.04	0.48	97	15	15	N
Killer whale	Eastern North Pacific Offshore	PAC	SWC	209	0.04	0.5	2.1	0	0	N
Killer whale	**Eastern North Pacific Southern Resident**	**PAC**	**AKC**	**78**	**0.04**	**0.5**	**0.8**	**0**	**0**	**N**
Short-finned pilot whale	California/ Oregon/ Washington	PAC	SWC	717	0.04	0.4	5.7	3.0	3.0	N
Baird's Beaked Whale	California/ Oregon/ Washington	PAC	SWC	313	0.04	0.5	2.0	0	0	N
Mesoplodont Beaked Whales	California/ Oregon/ Washington	PAC	SWC	2,734	0.04	0.5	27	0	0	N

APPENDIX 3 (revised 10/31/2002)

Stocks for which new assessment reports were written in 2002 are indicated by **bold** font.

SUMMARY OF 2002 PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS (FOR STOCKS UNDER NMFS JURISDICTION)

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fish. Mortality + Serious Injury	Strategic Status
Cuvier's Beaked Whale	California/ Oregon/ Washington	PAC	SWC	4,309	0.04	0.5	43	0	0	N
Pygmy Sperm Whale	California/ Oregon/ Washington	PAC	SWC	2,837	0.04	0.5	28	0	0	N
Sperm whale	California/ Oregon/ Washington	PAC	SWC	1,026	0.04	0.1	2.1	1.7	1.7	Y
Humpback whale	**Eastern North Pacific**	**PAC**	**SWC**	**774**	**0.08**	**0.1**	**1.6**	**≥ 1.2**	**≥ 0.8**	**Y**
Blue whale	Eastern North Pacific	PAC	SWC	1,716	0.04	0.1	1.7	0.0	0	Y
Fin whale	California/ Oregon/ Washington	PAC	SWC	1,581	0.04	0.1	3.2	0.4	0	Y
Bryde's whale	California/ Oregon/ Washington	PAC	SWC	11,163	0.04	0.5	n/a	0	0	N
Sei whale	California/ Oregon/ Washington	PAC	SWC	n/a	0.04	0.1	n/a	0	0	Y
Minke whale	California/ Oregon/ Washington	PAC	SWC	440	0.04	0.45	4.0	0	0	N
Rough-Toothed Dolphin	Hawaii	PAC	SWC	76	0.04	0.5	0.8	n/a	n/a	N
Risso's Dolphin	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
Bottlenose Dolphin	Hawaii	PAC	SWC	479	0.04	0.5	4.8	n/a	n/a	N
Pantropical spotted dolphin	Hawaii	PAC	SWC	2,040	0.04	0.5	20	n/a	n/a	N
Spinner dolphin	Hawaii	PAC	SWC	2,355	0.04	0.5	24	n/a	n/a	N
Striped dolphin	Hawaii	PAC	SWC	52	0.04	0.5	0.5	n/a	n/a	N

APPENDIX 3 (revised 10/31/2002)
Stocks for which new assessment reports were written in 2002 are indicated by **bold** font.

SUMMARY OF 2002 PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS (FOR STOCKS UNDER NMFS JURISDICTION)

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fish. Mortality + Serious Injury	Strategic Status
Melon-headed whale	Hawaii	PAC	SWC	81	0.04	0.5	0.8	n/a	n/a	N
Pygmy killer whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
False killer whale	**Hawaii**	**PAC**	**SWC**	**83**	**0.04**	**0.5**	**0.8**	**7**	**7**	**Y**
Killer whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
Pilot whale, short-finned	Hawaii	PAC	SWC	1,313	0.04	0.5	13	n/a	n/a	N
Blainville's beaked whale	Hawaii	PAC	SWC	43	0.04	0.5	0.4	n/a	n/a	N
Cuvier's beaked whale	Hawaii	PAC	SWC	29	0.04	0.5	0.3	n/a	n/a	N
Pygmy sperm whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
Dwarf sperm whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
Sperm whale	Hawaii	PAC	SWC	43	0.04	0.1	0.4	n/a	n/a	Y
Blue whale	Hawaii	PAC	SWC	n/a	0.04	0.1	n/a	n/a	n/a	Y
Fin whale	Hawaii	PAC	SWC	n/a	0.04	0.1	n/a	n/a	n/a	Y
Bryde's whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N

n/a indicates that data are not available.

APPENDIX 4 (revised 10/31/2002)

CHRONOLOGY OF U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS, 1995-2002.

Key: X = Revised with new information; R = Reprinted without revision, N = New stock, E = Eliminated stock, Shading indicates that a stock was not defined for that year.

U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000	2001	2002
PINNIPEDS							
CALIFORNIA SEA LION (*Zalophus californianus californianus*): U.S. Stock	X	X			X	R	R
HARBOR SEAL (*Phoca vitulina richardsi*): California Stock	X	X			X	X	R
HARBOR SEAL (*Phoca vitulina richardsi*): Oregon & Washington Coastal Waters Stock	X	X	X		X	R	X
HARBOR SEAL (*Phoca vitulina richardsi*): Washington Inland Waters Stock	X	X	X		X	R	X
NORTHERN ELEPHANT SEAL (*Mirounga angustirostris*): California Breeding Stock	X	X			X	R	X
GUADALUPE FUR SEAL (*Arctocephalus townsendi*)	X	R			X	R	R
NORTHERN FUR SEAL (*Callorhinus ursinus*): San Miguel Island Stock	X	X	X		X	R	R
HAWAIIAN MONK SEAL (*Monachus schauinslandi*)	X	X		X	X	X	X
CETACEANS - U. S. WEST COAST							
HARBOR PORPOISE (*Phocoena phocoena*): Morro Bay Stock							N
HARBOR PORPOISE ((*Phocoena phocoena*): Monterey Bay Stock							N
HARBOR PORPOISE ((*Phocoena phocoena*): San Francisco-Russian River Stock							N
HARBOR PORPOISE ((*Phocoena phocoena*): N California/S Oregon Stock							N
HARBOR PORPOISE (*Phocoena phocoena*): Central California Stock	X	X		X	X	X	E
HARBOR PORPOISE (*Phocoena phocoena*): Northern California Stock	X	X		X	X	X	E
HARBOR PORPOISE (*Phocoena phocoena*): Oregon/Washington Coast Stock	X	X	X	X	X	R	X[2]
HARBOR PORPOISE (*Phocoena phocoena*): Washington Inland Waters Stock	X	X	X	X	X	R	X
DALL'S PORPOISE (*Phocoenoides dalli*): California/Oregon/Washington Stock	X	X			X	R	R
PACIFIC WHITE-SIDED DOLPHIN (*Lagenorhynchus obliquidens*): California/ Oregon/Washington, Northern and Southern Stocks	X	X			X	R	R
RISSO'S DOLPHIN (*Grampus griseus*): California/Oregon/Washington Stock	X	X			X	R	R
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California Coastal Stock	X	X			X	X	R
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California/Oregon/Washington Offshore Stock	X	X			X	R	R

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Key: X = Revised with new information; R = Reprinted without revision, N = New stock, E = Eliminated stock, Shading indicates that a stock was not defined for that year.

U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000	2001	2002
STRIPED DOLPHIN (*Stenella coeruleoalba*): California/Oregon/Washington Stock	X	X			X	R	R
SHORT-BEAKED COMMON DOLPHIN (*Delphinus delphis*): California/Oregon/Washington Stock	X	X			X	R	R
LONG-BEAKED COMMON DOLPHIN (*Delphinus capensis*): California Stock	X	X			X	R	R
NORTHERN RIGHT-WHALE DOLPHIN (*Lissodelphis borealis*): California/Oregon/Washington Stock	X	X			X	R	R
KILLER WHALE (*Orcinus orca*): California/Oregon/Washington Pacific Coast Stock	X	X		E	E	E	E
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock	X	X		X	X	X	X
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Transient Stock	(INCLUDED IN ALASKA REPORTS)			X	X	R	(IN ALASKA REPORTS)
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Offshore Stock				N	X	R	R
SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): California/Oregon/Washington Stock	X	X		X	X	R	R
BAIRD'S BEAKED WHALE (*Berardius bairdii*): California/Oregon/Washington Stock	X	X			X	R	R
MESOPLODONT BEAKED WHALES (*Mesoplodon* spp.): California/Oregon/Washington Stocks	X	X	X		X	R	R
CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): California/Oregon/Washington Stock	X	X			X	R	R
PYGMY SPERM WHALE (*Kogia breviceps*): California/Oregon/Washington Stock	X	X			X	R	R
DWARF SPERM WHALE (*Kogia sima*): California/Oregon/Washington Stock	X	X			E	E	E
SPERM WHALE (*Physeter macrocephalus*): California/Oregon/Washington Stock	X	X		X	X	X	R
HUMPBACK WHALE (*Megaptera novaeangliae*): Eastern North Pacific Stock	X	X		X	X	X	X
BLUE WHALE (*Balaenoptera musculus*): Eastern North Pacific Stock	X	X			X	R	R
FIN WHALE (*Balaenoptera physalus*): California/Oregon/Washington Stock	X	X			X	X	R
BRYDE'S WHALE (*Balaenoptera edeni*): Eastern Tropical Pacific Stock	X	X			X	R	R
SEI WHALE (*Balaenoptera borealis*): Eastern North Pacific Stock	X	X			X	R	R
MINKE WHALE (*Balaenoptera acutorostrata*): California/Oregon/Washington Stock	X	X	X		X	R	R
CETACEANS - HAWAII							

APPENDIX 4 (revised 10/31/2002)

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U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000	2001	2002
ROUGH-TOOTHED DOLPHIN (*Steno bredanensis*): Hawaiian Stock	X	R			X	R	R
RISSO'S DOLPHIN (*Grampus griseus*): Hawaiian Stock	X	R			X	R	R
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): Hawaiian Stock	X	R			X	R	R
PANTROPICAL SPOTTED DOLPHIN (*Stenella attenuata*): Hawaiian Stock	X	R			X	R	R
SPINNER DOLPHIN (*Stenella longirostris*): Hawaiian Stock	X	R			X	R	R
STRIPED DOLPHIN (*Stenella coeruleoalba*): Hawaiian Stock	X	R			X	R	R
MELON-HEADED WHALE (*Peponocephala electra*): Hawaiian Stock	X	R			X	R	R
PYGMY KILLER WHALE (*Feresa attenuata*): Hawaiian Stock	X	R			X	R	R
FALSE KILLER WHALE (*Pseudorca crassidens*): Hawaiian Stock	X	R			X	X	X
KILLER WHALE (*Orcinus orca*): Hawaiian Stock	X	R			X	R	R
SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Hawaiian Stock	X	R			X	R	R
BLAINVILLE'S BEAKED WHALE (*Mesoplodon densirostris*): Hawaiian Stock	X	R			X	R	R
CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Hawaiian Stock	X	R			X	R	R
PYGMY SPERM WHALE (*Kogia breviceps*): Hawaiian Stock	X	R			X	R	R
DWARF SPERM WHALE (*Kogia sima*): Hawaiian Stock	X	R			X	R	R
SPERM WHALE (*Physeter macrocephalus*): Hawaiian Stock	X	R			X	R	R
BLUE WHALE (*Balaenoptera musculus*): Hawaiian Stock	X	R			X	R	R
FIN WHALE (*Balaenoptera physalus*): Hawaiian Stock	X	R			X	R	R
BRYDE'S WHALE (*Balaenoptera edeni*): Hawaiian Stock	X	R			X	R	R
APPENDIX TITLES	**APPENDIX NUMBERS**						
Summary of Pacific Stock Assessment Reports	1	3	1	2	3	3	3
Description of U.S. Commercial Fisheries		1			1	1	1
Cetacean Survey Effort		2			2	2	2
Review of New Information for Pacific Marine Mammal Stocks			2				

APPENDIX 4 (revised 10/31/2002)

CHRONOLOGY OF U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS, 1995-2002.

Key: X = Revised with new information; R = Reprinted without revision, N = New stock, E = Eliminated stock, Shading indicates that a stock was not defined for that year.

U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000	2001	2002
Chronology of U. S. Pacific Stock Assessment Reports				1	4	4	4
U.S. Fish and Wildlife Service California & Washington sea otter stock assessments					5	5	5

[1]The public comment, review and revision process has necessitated about a one year time lag between the draft revision and final publication of Marine Mammal Stock Assessment Reports. Therefore, in 1997, the Stock Assessment Report dates were changed to '1998' to match the 1998 publication year of the report.

[2]The Oregon/Washington coast stock of harbor porpoise previously included animals south to the California/Oregon border. Stock revisions based on genetic and sighting density data resulted in the southern boundary of this stock being moved north to Cape Blanco, Oregon (see stock assessment report for Oregon/Washington coast harbor porpoise).

Appendix 5. The following stock assessment reports were prepared by the U.S.Fish and Wildlife Service. NMFS includes these reports in this Technical Memorandum as a convenience to interested readers and in response to a recommendation from regional Scientific Review Groups.

Revised 10/4/1995

SOUTHERN SEA OTTER (*Enhydra lutris nereis*): California Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Southern sea otters breed and give birth in California year round, however the seasonality is not highly synchronous and the birth peak may extend over several months (Siniff and Ralls 1991, Riedman et al. 1994). The population ranges along the mainland coast from Pt. Ano Nuevo, Santa Cruz County south to Purisima Point, Santa Barbara County; an experimental population currently exists at San Nicolas Island, Ventura County. The initial translocation of sea otters to San Nicolas Island occurred in August 1987.

The population of southern sea otters historically ranged from northern California or Oregon to approximately Punta Abreojos, Baja California (Wilson el al. 1991). Harvest of sea otters during the 1700's and 1800's reduced the species throughout its range. In 1914, the total California population was estimated to be about 50 animals (California Department of Fish and Game 1976). The estimated carrying capacity in California ranges between 13,500 and 30,000 sea otters (Marzin and DeMaster, In prep.).

POPULATION SIZE

Data on population size and distribution of the southern sea otter have been gathered for more than 50 years. In 1982, a standardized survey technique was adopted to eliminate variation from future counts (Estes and Jameson 1988). This method involves shore-based censuses of approximately 80 percent of the population, supplemented with aerial surveys of the remaining 20 percent. These surveys are conducted twice each year (in spring and fall). The San Nicolas Island experimental population is surveyed approximately every two months.

Minimum Population Estimate

Based on the 1994 spring survey (actual count), the minimum southern sea otter population size of the mainland population is 2,359 individuals. Based on the most recent survey of the San Nicolas Island experimental population, the minimum sea otter population size is 17 individuals. Counts of sea otters at San Nicolas Island during 1994 and 1995 have ranged between 10 and 17 individuals.

Current Population Trend

Based on annual spring count totals since 1983, the southern sea otter population is continuing to increase. The mean growth rate from 1983 through 1994 is 5.7 percent (R. Jameson, National Biological Service, pers. comm., Estes et al., In press) (The 1994 count represented a 5.4 percent increase over 1993). Recent counts of the San Nicolas Island experimental population indicate a slight increase in the population; available information is inadequate to determine trends at this time.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The maximum growth rate (r_{max}) for sea otter populations is about 20 percent (Estes 1990). Except for California and Washington, all increasing sea otter populations for which data are available have grown at about this rate. Since the early 1900's, the California sea otter population increased at about 4 to 5 percent a year until the mid-1970's. Available information suggests that between 1976 and 1982 population growth ceased and possibly declined by as much as 20 percent. Counts from 1983 to 1994 have increased at about 5 to 6 percent per year (Estes et al., In press). In California, the r_{max} appears to be 6 percent.

Appendix 5.

ANNUAL HUMAN-CAUSED MORTALITY

Incidental drowning of sea otters in gill and trammel entangling nets has been a significant source of mortality (Wendell et al. 1985). Mortality assessments for southern sea otters in California's commercial fisheries have been based on direct observations. Monitoring of commercial fisheries was initiated in 1982. Extrapolations from the number of otters observed drowned and the proportion of the set-net fishery sampled indicated that from June 1982 to June 1984, an average of 80 sea otters drowned in gill and trammel nets each year (Wendell et al. 1985). The first of several State restrictions of gill and trammel net fishing to protect sea otters was enacted in 1985. The most recent restriction, California Senate Bill No. 2563, was enacted in 1990 and became effective on January 1, 1991. This bill prohibits the use of gill and trammel nets in waters shallower than 30 fathoms between Waddell Creek in Santa Cruz County and Point Sal in Santa Barbara County. Gill and trammel net fishing are prohibited within 30 fathoms around San Nicolas Island, Ventura County.

Since 1988, 26 otters have been observed or otherwise known to have drowned in legally set commercial fishing nets: 5 in 1988, 11 in 1989, 9 in 1990, and 0 in 1991 and 1992, 1 in 1993, and 0 in 1994. The net responsible for the 1993 mortality is of unknown origin. It may have been legally or illegally set, or a piece of netting set adrift in which the otter became entangled. In 1992, a dead sea otter was recovered by a California Department of Fish and Game warden in a crab pot located in 30 to 60 feet of water off Point Santa Cruz, Santa Cruz County. The level of take of southern sea otters in lobster and crab fisheries in California is unknown. Although the level of take is unknown, it has been postulated by some to have made a significant contribution to the lack of population growth in the colony of sea otters translocated to San Nicolas Island.

Other sources of human-caused mortality include shooting, boat strikes, capture and relocation efforts, oil spills and possibly elevated levels of polychlorinated biphenyls (PCBs) and other toxic contaminants.

FISHERIES INFORMATION

Fishing with set gillnets has been restricted throughout most of the range of the southern sea otter with one exception. Set gillnets are used by approximately 6 vessels (T. Price, National Marine Fisheries Service, pers. comm.) to catch halibut and flounder, along the coastline from Point Sal to Point Arguello, Santa Barbara County. Because this area is remote and difficult to access, this fishery is not monitored and no data exists on the level of take of southern sea otters.

Lobster and crab fishing occur within the range of the southern sea otter. Available information suggests that sea otters are accidentally caught and drowned in lobster and crab traps.

As part of the southern sea otter recovery effort, the Fish and Wildlife Service has attempted to establish a sea otter colony at San Nicolas Island. Public Law 99-625, which provided the legislative authority for the translocation of sea otters from the mainland to San Nicolas Island, specified that the area surrounding the translocation zone be designated a "management zone" from which sea otters are to be excluded by non-lethal means to prohibit range expansion and protect fishery resources south of Point Conception.

STATUS OF STOCK

The southern sea otter was designated as a threatened species in 1977 (42 FR 2965-2968) pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). Because of its threatened status, the southern sea otter also is designated as depleted under the Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 et seq.). Furthermore, the southern sea otter population is below its Optimum Sustainable Population level.

If the restrictions on the use of gill and trammel nets in areas inhabited by southern sea otters were lifted, the southern sea otter population would be designated as a "strategic stock" as defined by the Marine Mammal Protection Act, requiring constitution of a Take Reduction Team to advise on measures that could and should be taken to ensure that the incidental take of sea otters, by itself and in combination with other possible sources of non-natural mortality, does not exceed the calculated potential biological removal level.

POTENTIAL BIOLOGICAL REMOVAL

The Potential Biological Removal (PBR) for the California stock is 7 animals. PBR is the product of three

Appendix 5.

elements: the minimum population estimate (N_{min}); half the maximum net productivity rate (0.5 R_{max}); and a recovery factor (F_r). For the California sea otter stock, N_{min}=2,376; R_{max}= 6 percent; and F_r=0.1.

Calculating a PBR for the southern sea otter serves no practical purpose. Incidental take of the southern sea otter is not governed under section 118 of the Marine Mammal Protection Act.

REFERENCES

California Department of Fish and Game. 1976. A proposal for sea otter protection and research, and request for return of management to the State of California, January 1976. 2 Vols. Unpubl. rep.

Estes, J. A. 1990. Growth and equilibrium in sea otter populations. J. Anim. Ecol. 59:358-401.

Estes, J. A. and R. J. Jameson. 1988. A double-survey estimate for sighting probability of sea otters in California. J. Wildl. Manage. 52:70-76.

Estes, J. A., R. J. Jameson, J. L. Bodkin, and D. R. Carlson. (In Press) California sea otters. Our Living Resources 1995 - Mammals. National Biological Service.

Marzin, C. G. and D. P. DeMaster. (In prep.) Estimating the carrying capacity of sea otters (Enhydra lutris) along the California coast.

Riedman M. L, J. A. Estes, M. M. Staedler, A. A. Giles, and D. R. Carlson. 1994. Breeding patterns and reproductive success of California sea otters. J. Wildl. Manage. 58:391-399.

Siniff, D. B., and K. Ralls. 1991. Reproduction, survival and tag loss in California sea otters. Marine Mammal Science 7(3):211-229.

Wendell, F. E., R. A. Hardy, and J. A. Ames. 1985. Assessment of the accidental take of sea otters, *Enhydra lutris*, in gill and trammel nets. Mar. Res. Branch, Calif. Dep. Fish Game. Unpubl. rep. 30 pp.

Wilson, D. E., M. A. Bogan, R. L. Brownell, Jr., A. M. Burdin, and M. K. Maminov. 1991. Geographic variation in sea otters, *Enhydra lutris*. J. Mammal. 72(1):22-36.

Appendix 5.

Revised 10/4/1995

SEA OTTER (*Enhydra lutris kenyoni*): Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sea otters breed and give birth year-round (Riedman and Estes 1990). The peak pupping period for the Washington population is not defined; however, breeding and pupping seasons peak about 2-3 months later in Alaska than in California. The Washington population ranges from Neah Bay south to Destruction Island.

Enhydra lutris kenyoni historically ranged throughout the Aleutian Islands, originally as far north as the Pribilof Islands and in the eastern Pacific Ocean from the Alaskan Peninsula south along the coast to Oregon (Wilson el al. 1991). This subspecies was extirpated from most of its range during the 1700's and 1800's as the species was exploited for its fur. In 1969 and 1970, a total of 59 sea otters captured at Amchitka Island, Alaska were released in Washington (Jameson et al. 1982). The estimated carrying capacity in Washington has not been determined.

For management purposes pursuant to the Marine Mammal Protection Act of 1972, the range of this stock currently is being considered as within the boarders of the state of Washington.

POPULATION SIZE

The reintroduced population was not surveyed between 1970 and 1977. In 1977, the U.S. Fish and Wildlife Service surveyed the coast and counted only 19 sea otters. The population was surveyed again in 1978. Between 1981 and 1989 the population was surveyed every other year. Since 1989, data on size and distribution of the Washington sea otter population have been gathered annually using combined aerial and ground counts.

Minimum Population Estimate

Based on the 1994 spring survey (actual count), the minimum population size is 360. Survey conditions during 1994 were less than optimal and the Service believes that the population is probably slightly larger than this count.

Current Population Trend

Based on count totals from 1977 to the present, the Washington sea otter population is continuing to increase. Since 1989 (when the current survey method was initiated) through 1994, the population has grown at an average rate of 12 percent per year (R. Jameson, National Biological Service, pers. comm.).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The maximum growth rate (r_{max}) for sea otter populations is about 20 percent. Except for California and Washington sea otter populations, all increasing populations for which data are available have grown at about this rate (Estes 1990). In Washington, the r_{max} appears to be 12 percent.

ANNUAL HUMAN-CAUSED MORTALITY

Incidental drowning of sea otters in gill and trammel entangling nets has been a significant source of mortality for southern sea otters (Wendell et al. 1985). In 1992, a dead sea otter was recovered by a California Department of Fish and Game warden in a crab pot located in 30 to 60 feet of water off Point Santa Cruz. The level of take of southern sea otters in lobster and crab fisheries in California is unknown. Reports from Alaska further substantiate the incidental take of sea otters in traps fisheries.

Appendix 5.

Sea otters are susceptible to drowning in gill nets in Washington's coastal gill net fisheries, but documented incidental takes are rare. In Washington, one sea otter was killed in a tribal chinook salmon set-net in the vicinity of the mouth of the Ozette River on the north Washington coast. However, as the sea otter population expands, mortality in crab pot and tribal set-net fisheries may increase.

Other sources of human-caused mortality affecting the Washington population of sea otters are not well documented. Documented sources of human-caused mortality for the southern sea otter include shooting, boat strikes, capture and relocation efforts, oil spills and possibly elevated levels of polychlorinated biphenyls (PCBs) and other toxic contaminants. In Washington , an uncertain number of sea otters may have been killed in recent years by small oil spills.

Native Americans of the Pacific northwest have Tribal Rights to wildlife resources. These resources are claimed by the tribes to include sea otters. Currently there is no harvest of sea otters by the Native Americans; however, there is an interest to develop such a program.

FISHERIES INFORMATION

At present, there has been only one recorded otter-fishery interaction in Washington. Set gill nets are used by Native Americans to catch salmon along the north coast of Washington and the Strait of Juan de Fuca. This fishery operates out of Neah Bay. As the Washington sea otter population moves north, or if the fishery moves south, the probability of fisheries-related incidental take will increase.

As sea otters expand their range north or south, they will encounter several sport and commercial shellfish fisheries (urchins, razor clams, Dungeness crabs) along the coast. Evidence from California and Alaska suggests that incidental take of sea otter in crab traps may occur.

STATUS OF STOCK

The Washington sea otter has no formal Federal designation. It is legally designated as endangered by the State of Washington (Washington Administrative Code 232-12-014). The Washington sea otter population is below its Optimum Sustainable Population level.

POTENTIAL BIOLOGICAL REMOVAL

The Potential Biological Removal (PBR) for the Washington stock is 11 animals. PBR is the product of three elements: the minimum population estimate (N_{min}); half the maximum net productivity rate (0.5 R_{max}); and a recovery factor (F_r). For the Washington sea otter stock, N_{min}=360; R_{max}=12 percent; and F_r=0.5.

REFERENCES

Estes, J. A. 1990. Growth and equilibrium in sea otter populations. J. Anim. Ecol. 59:358-401.

Jameson, R. J., K. W. Kenyon, A. M. Johnson, and H. M. Wight. 1982. History at status of translocated sea otter populations in North America. Wildl. Soc. Bull. 10:100-107.

Riedman, M. L., and J. A. Estes. 1990. The sea otter (Enhydra lutris): behavior, ecology, and natural history. U.S. Fish and Wildlife Service, Washington, D.C., Biological Report 90(14). 126 pp.

Wendell, F. E., R. A. Hardy, and J. A. Ames. 1985. Assessment of the accidental take of sea otters, *Enhydra lutris*, in gill and trammel nets. Mar. Res. Branch, Calif. Dep. Fish Game. Unpubl. rep. 30 pp.

Wilson, D. E., M. A. Bogan, R. L. Brownell, Jr., A. M. Burdin, and M. K. Maminov. 1991. Geographic variation in sea otters, *Enhydra lutris*. J. Mammal. 72(1):22-36.