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Marine Mammal Stock Assessments: 2000

by

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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 a complete set of revised stock assessments for Pacific marine mammal stocks under NMFS jurisdiction. Stock Assessments for Alaskan marine mammals are published by the National Marine Mammal Laboratory (NMML) in a separate report. The southern sea otter, which is under the management jurisdiction of the USFWS, is also covered in a separate report.

The assessments in this report include stocks studied by the Southwest Fisheries Science Center (SWFSC, La Jolla, California and Honolulu, Hawaii) and the National Marine Mammal Laboratory (NMML, Seattle, Washington). Staff of the National Marine Mammal Laboratory wrote seven reports, including two stocks of harbor seals in Oregon and Washington, northern fur seal (San Miguel Island stock), two stocks of harbor porpoise in Oregon and Washington, and two stocks of Eastern North Pacific killer whales (Southern Resident and Transient stocks). Southwest Fisheries Science Center personnel prepared stock assessments for the remaining 48 stocks. A summary table for these revised stock assessment reports is provided in Appendix 4.

In the 2000 Stock Assessment Reports, descriptions of commercial fisheries that interact with or take marine mammals have been updated to include recent estimates of fishing effort and bycatch mortality. Where possible, fishery mortality sections for individual species have been updated to include information on fishery mortality through 1998. Mortality estimates reflect the most recent 5 years of available data (1994-98), with the exception of the California drift gillnet fishery, where mortality estimates are based on data from 1997-98 only. This reflects the fact that entanglement rates of marine mammals decreased after implementation of the Take Reduction Plan in 1997. New abundance estimates are available and have been included for 10 Hawaiian stocks and 25 U.S. West Coast stocks. There were changes in the status of three stocks: (1) the California/Oregon/Washington stock of short-finned pilot whale is no longer strategic, owing to a reduction in driftnet mortality; (2) the central California stock of harbor porpoise is now strategic, owing to increased mortality in the halibut set gillnet fishery; and (3) the Hawaii stock of false killer whale is now strategic, owing to serious injuries documented in the longline fishery. Of the remaining stocks, ten remain strategic and 44 non-strategic. The 10 strategic stocks include 10 endangered species that are automatically considered strategic. The stock assessment report for the California/Oregon/Washington stock of dwarf sperm whale (*Kogia simus*) has been discontinued, owing to a lack of reliable sighting or stranding records off the U.S. west coast since the 1970s. A proposed change in the species name of the dwarf sperm whale (from *simus* to *sima*) is briefly reviewed in the Hawaii report for this species (Rice 1998). The stock of blue whale formerly known as the '*California/Mexico stock*' has been renamed the '*Eastern North Pacific stock*' to reflect current knowledge of whale movements between the U.S. west coast and the eastern tropical Pacific (Mate et al. 1999, Stafford et al. 1999). Sighting plots for each species have been updated by eliminating older Minerals and Management Service (MMS) survey data from the 1970s and 1980s and by including more recent NMFS survey data from 1991-98. The exception to this is the sighting plot for the California/Oregon/Washington stock of short-finned pilot whale, which retains the MMS sighting data prior to the 1983-84 El Niño event, in part to reflect the rarity of pilot whales along the U.S. west coast since that event.

The following are DRAFT Stock Assessment Reports that are being made available for public comment. Special fonts are used to indicate information that was deleted from (~~strikeout~~) or added to (redline) the previous stock assessment reports (Barlow et al. 1997; Barlow et al. 1998; Hill and DeMaster 1998; Forney et al. 1999). Earlier versions of these draft stock assessment reports were reviewed by members of the Pacific and Alaska Scientific Review Groups and by Doug DeMaster, Scott Hill, and Paul Wade; 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.

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Revised ~~8/1/97~~ 01/03/00

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.

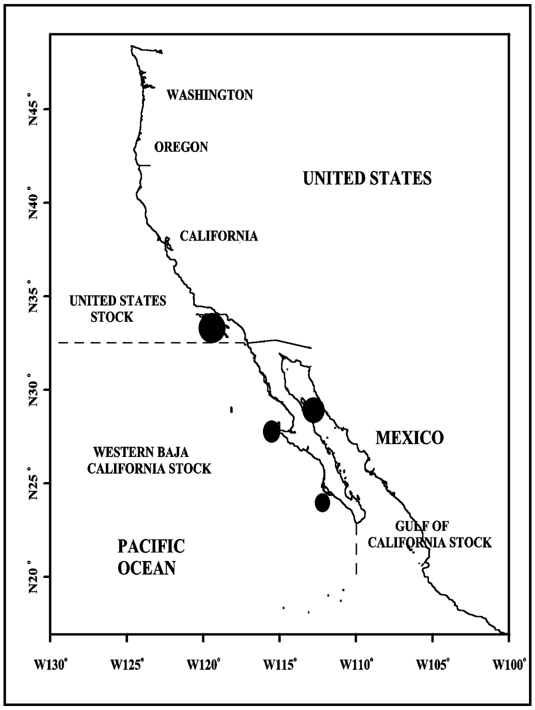

Figure 1. Geographic range of California sea lions showing stock boundaries and locations of major rookeries.

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 ~~1995~~1999 (~~37,818~~ 42,388) was adjusted for an estimated 15% pre-census mortality (Boveng 1988; Lowry et al. 1992), giving an estimated ~~43,490~~ 48,746 live births in the population. The fraction of newborn pups in the population (~~23.1%~~ 22.8% to 23.9% ~~26.0%~~) 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 (~~5.4%~~ 5.0% to ~~8.3%~~ 6.2% yr^{-1}, respectively, see below). Multiplying the number of pups born by the inverse of these fractions (~~4.32~~ 4.39 to ~~3.85~~ 4.19) results in population estimates ranging from ~~188,000~~ 214,000 to ~~167,000~~ 204,000 (respectively).

Minimum Population ~~Size~~ 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 ~~1995~~ 1999 breeding season. The minimum population size of the U.S. stock is ~~111,339~~ 109,854 (NMFS unpubl. data~~, Beeson and Hanan 1996~~). It includes all California sea lions counted during the July ~~1995~~ 1999 census at the four rookeries in southern California and at the haulout sites located between Point ~~Arguello~~ 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 ~~1995~~ 1999 (Figure 2) were compiled from the literature, NMFS reports, ~~and~~ unpublished NMFS data, and Lowry 1999 (the literature up to 1992 is listed in Lowry et al. 1992). Pup counts from 1975 through ~~1995~~ 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. ~~Two~~ Three major declines in the number of pups counted occurred during El Niño events in 1983, ~~and~~ 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 ~~5.4%~~ 5.0% between 1975 and ~~1995~~ 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 ~~8.3%~~ 6.2% annually.

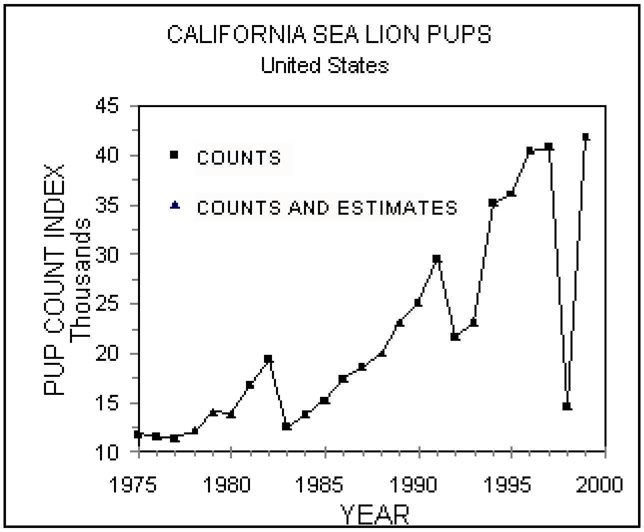

Figure 2. U.S pup count index for California sea lions (1975-99).

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 Niño's, 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 Niño's, 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 Niño's 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 Niño's 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 Niño's and does not signal that the population has reached carrying capacity. The severity, timing, length, and frequency of future El Niño's 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 ~~fishery~~ human related ~~mortality~~ mortalities ~~takes~~ take a ~~large~~ fraction of the net production. Net productivity was, therefore, calculated for 1980-~~1995~~ 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 ~~the harvest rate~~ human related mortalities (fishery and non-fishery ~~mortality~~ mortalities in year *I* divided by population size in year *I*). For California sea lions, the total ~~fishery~~ mortalities estimated from NMFS, California Dept. of Fish and Game, ~~and~~ 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, ~~1,899, 3,500, 2,024, 933, 750,~~ 1,901, 3,520, 2,039, 946, 827, 1,107, 1,502, 1,435, 1,348 for 1980 to ~~1995~~ 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 ~~in press.~~ 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 ~~1995~~ 1999 the net productivity rate averaged ~~11.3%~~ 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, ~~and~~ 1992, and 1998) and the high net production rate during El Niño recovery years ~~for~~ (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 ~~(111,339)~~ (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 ~~6,680~~ 6,591 sea lions per year.

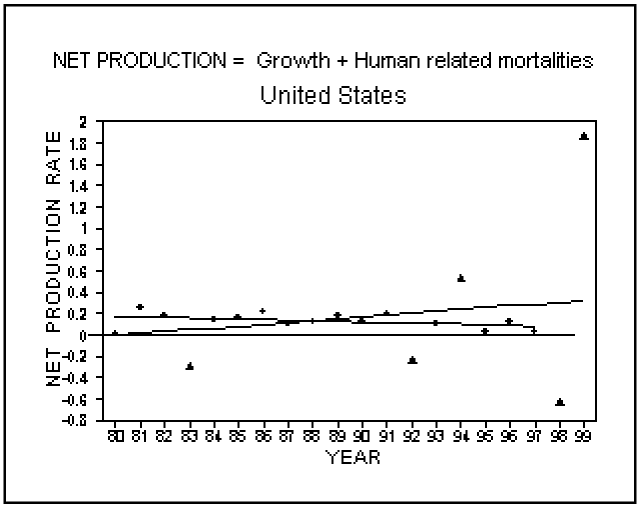

Figure 3. Net productivity rates and regression ~~line~~ lines estimated from pup counts with corrections for incidental human related mortalities ~~harvest in commercial fisheries~~. Thick line excludes El Niño years and El Niño recovery years (i.e., triangles); thin line includes all years.

ANNUAL HUMAN-CAUSED MORTALITY

~~Fishery~~ Fisheries Information

California sea lions are killed incidentally in set and drift gillnet fisheries (~~Brown and Jeffries 1993;~~ Hanan et al. 1993~~;~~ Barlow et al. 1994; Julian 1997, Julian and Beeson, ~~in press~~ 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). 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, 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 ~~non-gillnet~~ 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 ~~5~~ 17 additional mortalities and 17 injuries occurred in ~~1995~~ 1998 as a result of fishing net entanglement and ~~2~~ 24 additional mortalities and 31 injuries from ~~fishing hook~~ hook and line fisheries ~~injuries~~.

Drift gillnet fisheries for swordfish and sharks ~~also~~ exist along the entire Pacific coast of Baja California, Mexico and may take animals from the ~~same population~~ 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 ~~29~~ 31 vessels in ~~1992~~ 1993. ~~(Sosa-Nishizaki et al. 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 serious injury of California sea lions in commercial fisheries that might take this species ~~(Brown and Jeffries 1993, NMFS 1995, Julian and Beeson in press, M. Perez per. comm, P. Olesiuk per. comm., Appendix 1)~~(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	~~1991~~	observer	~~9.8%~~	~~4~~	~~41 (0.58)~~	
	~~1992~~		~~13.6%~~	~~9~~	~~66 (0.34)~~	
	~~1993~~		~~13.4%~~	~~11~~	~~82 (0.42)~~	~~49 (0.21)~~
	1994	observer	17.9%	5	28 (0.40)	158 (0.23)[1]
	1995		15.6%	4	26 (0.45)	
	1996		12.4%	4	36 (0.55)	
	1997		23.0%	36	201(0.34)	
	1998		20.0%	98	114 (0.23)	
CA set gillnet fishery for halibut and angel shark	~~1991~~	observer	~~9.8%~~	~~142~~	~~1,842 (0.16)~~	
	~~1992~~		~~12.5%~~	~~338~~	~~3,418 (0.28)~~	
	~~1993~~		~~15.4%~~	~~237~~	~~1,942 (0.13)~~	
	1994	observer	7.7%	109	905 (0.15)	~~815 (0.09)~~ [2]
	1995	estimate	0%	-	724 (0.08) [1]	1,012 (0.04)[2]
	~~1995~~	~~self-reporting~~	~~-~~	~~10~~	~~-~~	
	1996	extrapolated	0%	-	999 (0.06) [1]	
	1997	estimate	0%	-	1,206 (0.06) [1]	
	1998		0%	-	1,228 (0.07) [1]	
~~**OR Columbia R. gillnet fishery**~~	~~1991~~	~~observer~~	~~3.8%~~		~~16 (1.0)~~	
	~~1992~~		~~3.9%~~		~~22 (0.58)~~	~~19(0.54)~~
~~**CA, OR, and WA salmon troll fishery**~~	~~1990-92~~	~~logbook~~			~~Avg. Annual reported take = 128~~	~~not available~~
~~**WA Puget Sound salmon drift gillnet fishery**~~	~~1990-92~~	~~logbook~~			~~Avg. Annual reported take = 24~~	
	~~1993~~	observer	~~2% non-Indian~~	~~0~~	~~0~~	~~12~~
	1994		7% both	0	0	0
~~**CA herring purse seine fishery**~~	~~1990-92~~	~~logbook~~			~~Avg. Annual reported take = 2~~	~~not available~~
~~**CA anchovy, mackerel, and tuna purse seine fishery**~~	~~1990-92~~	~~logbook~~			~~Avg. Annual reported take = 2.67~~	~~not available~~
~~**CA squid purse seine fishery**~~	~~1990-92~~	~~logbook~~			~~Avg. Annual reported take = 3~~	~~not available~~

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
WA, OR, CA domestic groundfish trawl fishery (At-sea processing Pacific whiting fishery only)	~~1991~~ ~~1992~~ ~~1993~~ 1994 1995 1996 1997 1998	observer	~~51.1% of catch~~ ~~75.3% of catch~~ ~~35.3% of catch~~ ~~58.8~~53.8% ~~of catch~~ ~~61.2~~56.2% ~~of catch~~ 65.2% 65.7% 77.3%	~~0~~ ~~0~~ ~~0~~ 1 0 0 0 1	~~0~~ ~~0~~ ~~0~~ 2(0.68) 0 0 0 1(0.48)	1(0.48)
~~**WA, OR, CA commercial passenger fishing vessel fishery**~~	~~1990-93~~	~~reports~~			~~2~~	~~2~~
CA salmon net pen fishery	~~1990-93~~	~~reports~~			~~0.2/yr~~	~~0.2~~
WA, OR salmon net pen fishery	~~1990-92~~ 1996 1997 1998	logbook		4 9 9	~~3.3/yr~~ 4 9 9	~~not available~~ 7(0.39)
Canada: BC salmon pen fishery	~~1991~~ ~~1992~~ ~~1993~~ 1994 1995 1996	reports			~~2~~ ~~6~~ ~~15~~ 13 23 54	~~17~~ 30(0.71)
Minimum total annual takes						~~915~~1,208 (0.05)

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

[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.

~~[2] Set gillnet fishing effort was reduced in 1994-95 (Appendix 1); consequently, California set gillnet mortality was averaged for those years only.~~

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 ~~in press~~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 ~~1995~~ 1998 from the California Marine Mammal Stranding Network (CMMSN) and the Oregon and Washington stranding ~~database~~ databases ~~also~~ shows the following non-fishery related mortality: boat collision (~~2~~ 3 mortalities), entrainment in power plants (~~21~~ 30 mortalities), and shootings (~~29~~ 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 ~~1995~~ 1998 was ~~52~~. 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.

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 (~~915~~ 1131 fishery-related mortalities plus ~~59~~ 141 from other sources) is less than the PBR (~~6,680~~ 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 ~~8.3%~~ 6.2% per year, and the fishery mortality is ~~declining~~ increasing.

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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).

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.

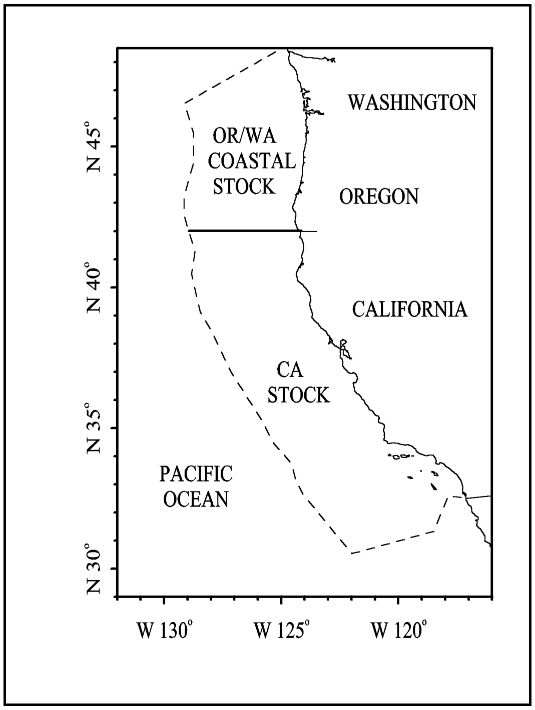

Figure 1. Stock boundaries for the California and Oregon/Washington coastal stocks of harbor seals. Dashed line represents the U.S. EEZ.

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.). Another survey is planned for 2000.

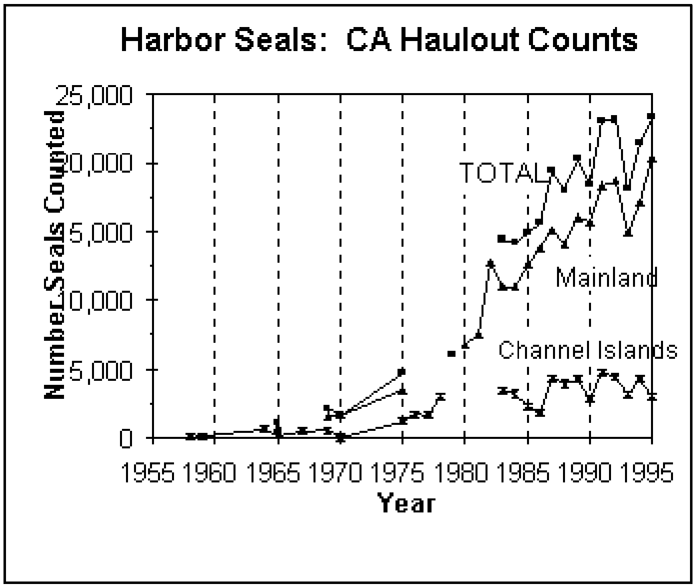

Figure 2. Harbor seal haulout counts in California during May/June (Hanan 1996).

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 the mid-1980s; a kill this large would have depressed population growth rates appreciably. Net

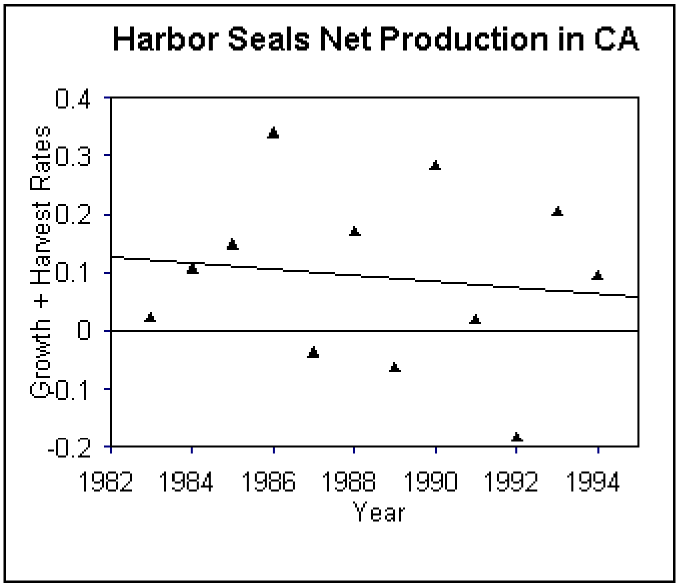

Figure 3. Net production rates and regression line estimated from haulout counts and fishery mortality.

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 ~~harvest~~ 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 (1/2 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.

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.

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~~, in press~~; 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 ~~1991-95~~	observer data	12-23% ~~10-18%~~	0	0,0,0,0,0	0[1]
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	1991	observer data	9.8%	42	601 (0.23)	n/a ~~228 (0.18) [2]~~
	1992		12.5%	90	1,204 (0.47)	
	1993		15.4%	71	475 (0.13)	
	1994		7.7%	23	227 (0.33)	
	1995	extrapolated estimate	0.0%	-	228 (0.13) [1]	
	1996		0.0%	-	296 (0.08) [1]	
	1997		0.0%	-	349 (0.08) [1]	
	1998		0.0%	-	392 (0.10) [1]	
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 ~~6~~	4 ~~6~~
Total annual takes						n/a ~~>234 (0.18)~~

[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.

~~[2] Set gillnet fishing effort was reduced in 1994-95 (Appendix 1); consequently, California set gillnet mortality was averaged for those years only.~~

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 that fishery has not been observed since 1994, average annual mortality cannot be accurately estimated for the recent years (1995-98). ~~and because effort in that fishery was reduced dramatically due to area closures starting in 1994, mortality for this stock will be estimated as an average of the years since 1994.~~ Rough estimates for 1995-1998 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. ~~The average estimated annual mortality for harbor seals in gillnet fisheries for the three most recent years of monitoring (1994-95) is 228. Data from~~ 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). ~~indicate that 6 additional harbor seals died in 1995 from injuries caused by fishing hooks.~~

~~Fishery Mortality Rates~~

~~Annual gillnet mortality may have been as high as 5-10% of the California harbor seal population in the mid-1980s. A kill this large would have strong influences on population growth rates and would depress them appreciably. Most of the kill was in the southern half of the State (Hanan et al. 1988; Hanan and Diamond 1989) and most of the mainland seals are in the northern half of California (Hanan 1993). This differential kill rate by geographic areas has not been investigated but may be an important factor in harbor seal dynamics in California.~~

Other Mortality

The California Marine Mammal Stranding database maintained by the National Marine Fisheries Service, Southwest Region, contains the following ~~9~~ records of human-related harbor seal mortalities and injuries in 1995-98: (1) boat collision (10 mortalities, 2 injuries) ~~(1 mortality)~~, (2) entrainment in power plants (20 ~~5~~ mortalities), and (3) shootings (9 ~~3~~ 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. ~~Because their total annual mortality rate (234 fishery-related mortalities plus 9 from other sources)~~ 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 ~~over the last 2 years (228 animals per year) is~~ 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. All west-coast harbor seals that were 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).

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Revised ~~12/15/98~~ 01/03/00

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, ~~Bigg~~ 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).

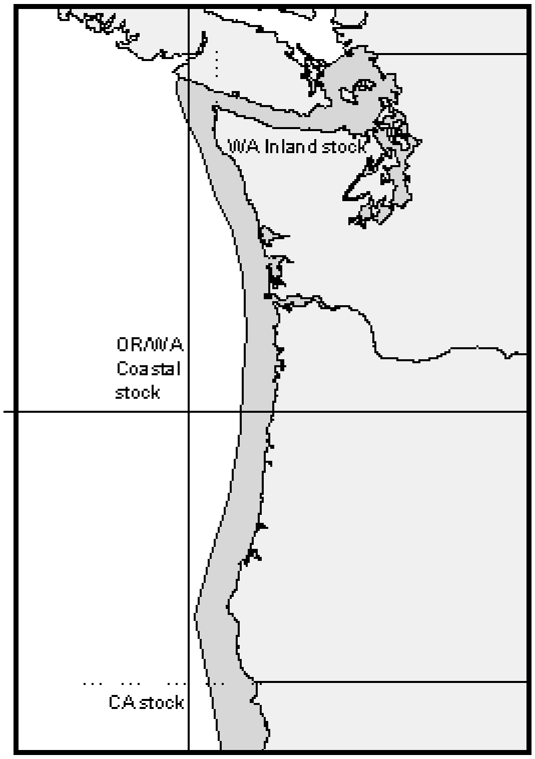

Figure 1. Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

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 and Washington Coast stock. Three harbor seal 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 seal stocks 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 (ODF~~&~~W and WDF~~&~~W) during the 1997 ~~1996~~ pupping season. Total numbers of hauled-out seals (including pups) were counted during these surveys. In 1997 ~~1996~~, the mean count of harbor seals occurring along the Washington coast was 11,864 ~~10,685~~ (CV=0.028 ~~0.011~~) animals (WDFW, unpubl. data; NMML, unpubl. data ~~Jeffries et al. 1997~~). In 1997 ~~1996~~, the mean count of harbor seals occurring along the Oregon coast and in the Columbia River was 5,247 ~~6,421~~ (CV=0.042) animals (ODFW, unpubl. data; Brown 1997, Jeffries et al. 1997). Combining these counts results in 17,111 ~~17,106~~ (CV=0.023 ~~0.017~~) harbor seals in the Oregon and 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 pattern 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 1995). Using ~~Utilizing~~ this correction factor results in a population estimate of 26,180 ~~26,172~~ (17,111 ~~17,106~~ x 1.53; CV=0.069 ~~0.067~~) for the Oregon and Washington Coast stock of harbor seals in 1997 ~~1996~~ (WDFW, unpubl. data; NMML, unpubl. data; ODFW, unpubl. data ~~Jeffries et al. 1997~~).

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 log-normal 20th percentile of the 1997 population estimate ~~(N) of 26,172 and its associated CV(N) of 0.067, N_{MIN}~~ for this stock is 24,705 ~~24,733~~ 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 bounty hunting. 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 a state-hired seal hunter, as well as bounty hunters (Pearson 1968). The population remained relatively low during the 1960s, but since the termination of the harbor seal bounty program and protection provided by the Marine Mammal Protection Act (MMPA) harbor seal counts for this stock have increased from 6,389 in 1977 to 17,111 ~~17,106~~ in 1997 ~~1996~~ (WDFW, unpubl. data; NMML, unpubl. data; ODFW, unpubl. data ~~H. Huber, unpubl. data; S. Jeffries, unpubl. data; R. Brown, 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. Since 1991, however, this stock has 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). It is possible that the lower total counts for the population as a whole may have resulted from changes in haulout behavior. Increased disturbance, reduced food availability necessitating longer foraging periods, or other unknown reasons may have caused a larger number of seals to be in the water during the surveys (Jeffries et al. 1997).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

From 1978 to 1993, counts of harbor seals throughout Washington state increased at an annual rate of 7.68% (Huber 1995). The Oregon and Washington Coast harbor seal stock increased at an annual rate of 7% ~~11%~~ from 1983-1992 ~~1977-82,~~ and ~~then~~ at 4% ~~5.5%~~ from 1983-1996~~1992~~ (Jeffries et al. 1997 ~~H. Huber, unpubl. data; S. Jeffries, unpubl. data; R. Brown, unpubl. data~~). Because the population was not at a very low level, the observed rates of increase will underestimate the maximum net productivity (R_{MAX})~~, although the 11% rate may be a reasonable approximation for this stock of harbor seals~~. Therefore ~~However~~, until additional data 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 ~~defined~~ as the ~~product of the~~ minimum population estimate (24,705) times one-half the default maximum theoretical net growth ~~productivity~~ rate for pinnipeds (½ of 12%) times~~, and~~ a recovery factor~~: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is~~ of 1.0~~, the value~~ (for stocks thought to be within OSP; ~~(~~Wade and Angliss 1997), resulting in a PBR of 1,482 harbor seals per year. ~~Thus, for the Oregon and Washington Coast stock of harbor seals, PBR = 1,484 animals (24,733 x 0.06 x 1.0).~~

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

With the exception of 1994, NMFS observers monitored the northern Washington marine set gillnet fishery during 1993-1998 ~~1990-1996~~ (Gearin et al. 1994, 1999; P. Gearin, unpubl. data). For the entire fishery (coastal + inland waters), observer coverage ranged from approximately ~~47-87~~ 40 to 98% during those years. Fishing effort is conducted within the range of both stocks of harbor seals (Oregon/Washington Coast and Inland Washington stocks) occurring in Washington State waters. Some of the animals taken in the inland waters portion of the fishery (see stock assessment report for the Inland Washington stock for details) may have been animals from the coastal stock. Similarly, some of the animals taken in the coastal portion of the fishery may have been from the inland stock. 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 Inland Washington stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon/Washington Coast stock. However, as noted, 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 1995). Accordingly, Table 1 includes data only from that portion of the northern Washington marine set gillnet fishery occurring within the range of the Oregon and Washington Coast stock (those waters south and west of Cape Flattery), where observer coverage was 100% in 1995-1997. No fishing effort occurred in the coastal portion of the fishery in 1993 or 1998 and, as noted above, no observer program occurred in 1994. Data from 1993 to 1998~~1990-96~~ are included in ~~the t~~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 ~~5.6~~ (CV=0.52~~.33~~) harbor seals per year from this stock.

The WA/OR/CA groundfish trawl fishery (Pacific whiting component) was monitored for incidental take during 1994-1998~~1990-96~~. The only harbor seal mortalit~~y~~ies occurred in 1996 and 1997, ~~a~~ years in which observer coverage (based on observed tons) was 65 and 66%, respectively. ~~The observed~~ Both mortalit~~y~~ies occurred during ~~an~~ unmonitored hauls and therefore were ~~was~~ not used to estimate mortality for the entire fishery in those years. ~~Although coverage was 65%~~ However, observers monitored 100% of the vessels during the fishery and~~. As a result,~~ the reported mortalit~~y~~ies are ~~is~~ thought to be the only harbor seal mortalit~~y~~ies in that fishery. The mean estimated mortality from 1994 to 1998 ~~1992-96~~ for monitored hauls in this fishery is zero ~~0.2 (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 and Washington Coast stock) in ~~due to~~ commercial and tribal fisheries ~~from 1990 through 1996 and calculation of the mean annual mortality rate~~ that might take this species; n/a indicates that data are not available. All entanglements resulted in the death of the animal. ~~Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1992 to 1996 (or the most recent 5 years of available data) are used in the mortality calculation when more than 5 years of data are provided for a particular fishery.~~ Coefficients of variation for mortality estimates are provided in parentheses, when available. Mean annual takes are based on 1994-98 data unless otherwise noted.

Fishery name	Years	Data type	Percent ~~Range of~~ observer coverage	Observed mortality ~~(in given yrs.)~~	Estimated annual mortality ~~(in given yrs.)~~	Mean annual ~~mortality~~ takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery: coastal waters)	~~90-96~~ 93 94 95 96 97 98	obs data	~~68-100%~~ no fishery 0% 100% 100% 100% no fishery	~~5, 7, 0, n/a,~~ 0 n/a 3 9 13 0	~~6, 10, 0, n/a,~~ 0 n/a 3 9 13 0	5 ~~5.6~~ (~~CV=~~ 0.52 ~~.33~~)
WA/OR/CA groundfish trawl (Pacific whiting component)	~~90-96~~ 94 95 96 97 98	obs data	~~44-72%~~ 53.8% 56.2% 65.2% 65.7% 77.3%	~~0, 0, 0, 0,~~ 0 0 ~~1~~ 0 0 0	~~0, 0, 0, 0,~~ 0 0 ~~1~~ 0 0 0	0 ~~0.2~~ ~~(CV=1.0)~~
	96 97	unmonitored hauls		1 1		0.4 (n/a)
~~WA/OR lower Columbia River drift gillnet~~	~~91-93~~	~~obs data~~	~~5-27%~~	~~9, 15, 1~~	~~233, 192, n/a~~	~~n/a~~ ~~(see text)~~

Fishery name	Years	Data type	Percent ~~Range of~~ observer coverage	Observed mortality ~~(in given yrs.)~~	Estimated annual mortality ~~(in given yrs.)~~	Mean annual ~~mortality~~ takes (CV in parentheses)
WA Grays Harbor salmon drift gillnet	91-93	obs data	4-5%	0, 1, 1	0, 10, 10	6.7 (~~CV=~~0.50)
WA Willapa Bay drift gillnet	91-93	obs data	1-3%	0, 0, 0	0, 0, 0	0
~~Observer program total~~						~~12.5~~ ~~(CV=.31)~~
				Reported mortalities		
WA Willapa Bay drift gillnet	~~90-96~~ 90-98	self reports	n/a	0, 0, 6, 8, n/a, n/a, n/a, n/a, n/a	n/a	3.5 (n/a) see text
WA/OR salmon net pens	~~90-96~~ 94-98	self reports	n/a	~~0, 2, 0, 0,~~ n/a, n/a, n/a, n/a, n/a	n/a	~~0.5~~ 0
Minimum total annual takes ~~mortality~~						15.6 (0.36) ~~16.5~~ ~~(CV=.31)~~

The Washington and Oregon Lower Columbia River drift gillnet fishery was monitored during 1991-93 (Brown and Jeffries 1993, Matteson et al. 1993c, Matteson and Langton 1994a)~~. In 1991~~, and observed~~rs recorded 9~~ harbor seal mortalities, incidental to the fishery, ~~resulting in an~~ were extrapolated to estimate~~d~~ total harbor seal mortality ~~kill of 233 seals (CV=0.37)~~. ~~The observed effort was 2,582 sets, representing an observer coverage of 4.7%. In 1992, 15 harbor seal mortalities incidental to the fishery were observed, resulting in an extrapolated estimated total kill of 192 seals (CV=0.32). The observed effort was 1,545 sets, representing an observer coverage of 27.2%. In 1993, 1 harbor seal mortality was observed incidental to the fishery. The observed effort was 518 sets, representing an observer coverage of 4.6%. Due to the reduced sampling regime, the mortality was not extrapolated to estimate total kill for the fishery in 1993. Using only the 1991-92 data, the mean estimated mortality for this fishery is 213 (CV=0.10) harbor seals per year.~~ However, fishing effort has been dramatically reduced since the 1991-92 fishing seasons~~. For instance,~~ (e.g., during 1994 the fishery was open for only 3 days and in 1995 there was no fishery) and few, if any, mortalities occur in the current fishery. ~~Therefore, the large mortality estimate based on the 1991-92 data is no longer applicable and a reliable estimate for this fishery is not available.~~

The Washington Grays Harbor salmon drift gillnet fishery was also monitored from 1991-93 (Herczeg et al. 1992a; Matteson and Molinaar 1992; Matteson et al. 1993a; Matteson and Langton 1994b, ~~Matteson and Langton~~ 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 1 harbor seal mortality incidental to the fishery, resulting in an extrapolated estimated total kill of 10 seals (CV=1.0). In 1993 observers recorded 1 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 from 1991-93 is 6.7 (CV=0.50) harbor seals per year (Table 1). No observer data are available for this fishery after 1993.

Combining the estimates from the northern Washington marine set gillnet (5 ~~5.6~~), WA/OR/CA groundfish trawl (0 from monitored hauls + 0.4 from unmonitored haul data ~~0.2~~), and Washington Grays Harbor salmon drift gillnet (6.7) fisheries results in an estimated mean mortality rate in observed fisheries of 12.1 ~~12.5~~ harbor seals per year from this stock.

The Washington Willapa Bay drift gillnet fishery was also monitored at low levels of observer coverage from 1991-93 (Herczeg et al. 1992a, 1992b; Matteson and Molinaar 1992; Matteson et al. 1993b; Matteson and Langton 1994c, ~~Matteson and Langton~~ 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).

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 ~~1990~~ 1994 and 1998 ~~1996~~, there were no fisher self-reports of any harbor seal mortalities. ~~from two unobserved fisheries (Table 1) resulted in an annual mean of 4 harbor seal mortalities from interactions with commercial fishing gear.~~ 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 ~~not available~~ for 1994, not available for ~~and~~ 1995, and considered unreliable after 1995 ~~for 1996~~ (see Appendix 4 of Hill and DeMaster, 1998 ~~in press~~).

Other Mortality

Strandings of harbor seals resulting from collisions with boats, from gunshot injuries, or entangle~~d~~ment in line unrelated to fisheries are another source of mortality data. During the 5-year period from ~~1992~~ 1994 to 1998, ~~1996 the only~~ human-related mortalities or serious injuries ~~harbor seal strandings of animals from this stock~~ occurred in ~~1993 (5 animals) and~~ 1994 (4 ~~animals~~), 1997 (2) and 1998 (2), resulting in an estimated annual mortality of 1.6 harbor seals (rounded to 2) from this stock during 1994 to 1998 ~~1992-96~~. 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 Northwest Indian tribes have developed, or are in the process of developing, regulations for ceremonial and subsistence harvests of harbor seals 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.

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 ~~17~~ + 2=18 ~~19~~) does not exceed the PBR (1,482 ~~1,484~~). Therefore, the Oregon and 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 ~~17~~; based on observer data (12 ~~13~~) and self-reported fisheries information (4) where observer data were not available or failed to detect harbor seal mortality) is also less than 10% of the calculated PBR (148) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The stock size increased until 1992, but has declined in recent years. Evidence indicates the Oregon component of this stock is likely within its Optimum Sustainable Population (OSP) (Jeffries et al. 1997), although quantitative analyses in support of this have not yet been completed.

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Revised ~~12/15/98~~ 01/03/00

HARBOR SEAL (*Phoca vitulina richardsi*): Inland Washington 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, ~~Bigg~~ 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).

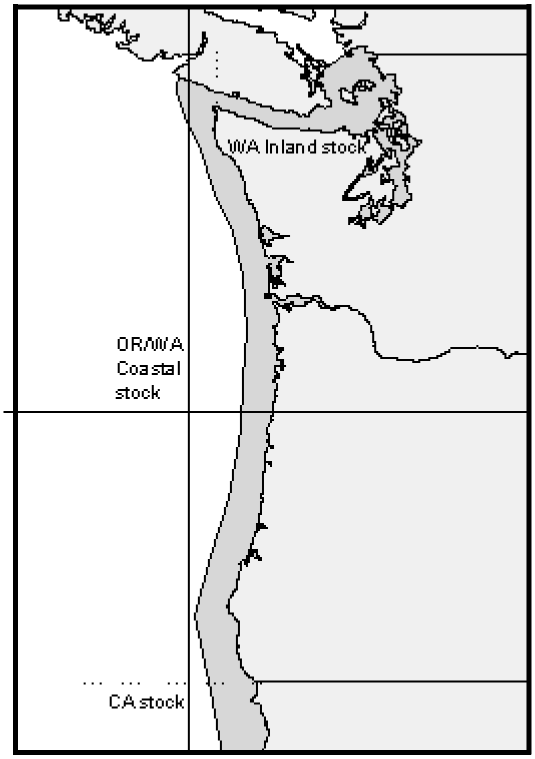

Figure 1. Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

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 Inland Washington stock. Three harbor seal 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 seal stocks 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 1997 ~~1996~~, during which time the total number of hauled-out seals (including pups) were counted. In 1997 ~~1996~~ the mean count of harbor seals occurring in Washington's inland waters was 10,494 ~~11,135~~ (CV=0.017 ~~0.0160~~) animals (WDFW, unpubl. data; NMML, unpubl. data ~~Jeffries et al. 1997~~).

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 1995). Using ~~Utilizing~~ this correction factor results in a population estimate of 16,056 ~~17,036~~ (10,494 ~~11,135~~ x 1.53; CV=0.067) for the Inland Washington stock of harbor seals (WDFW, unpubl. data; NMML, unpubl. data).

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 log-normal 20th percentile of the 1997 population estimate ~~(N) of 17,036 and its associated CV(N) of 0.067, N_{MIN}~~ for this stock is 15,174 ~~16,104~~ 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 bounty hunting. 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 protection provided by the Marine Mammal Protection Act (MMPA), harbor seal numbers in Washington have increased (Jeffries 1985).

Between 1983 and 1996, the annual rate of increase for this stock was 6%. Since 1991, this stock has 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 1983 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, the observed rate of increase will underestimate the maximum net productivity (R_{MAX}). Therefore, until additional data 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 ~~defined~~ as the ~~product of the~~ minimum population size (15,174) times one-half the default maximum theoretical net growth ~~productivity~~ rate for pinnipeds (½ of 12%) times~~, and~~ a recovery factor~~: PBR = N_{MIN} x $0.5R_{MAX}$ x F_R. The recovery factor (F_R) for this stock is~~ of 1.0~~, the value~~ (for stocks of unknown status that are increasing in size~~; (~~Wade and Angliss 1997), resulting in a PBR of 910 harbor seals per year. ~~Thus, for the Inland Washington stock of harbor seals, PBR = 966 animals (16,104 x 0.06 x 1.0).~~

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

With the exception of 1994, NMFS observers monitored the northern Washington marine set gillnet fishery during 1993-1998 ~~1990-1996~~ (Gearin et al. 1994, 1999; P. Gearin, unpubl. data). For the entire fishery (coastal + inland waters), observer coverage ranged from approximately ~~47-87~~ 40 to 98% during those years. Fishing effort is conducted within the range of both stocks of harbor seals (Oregon/Washington Coast and Inland Washington stocks) occurring in Washington State waters. Some of the animals taken in the inland waters portion of the fishery may have been animals from the coastal stock. Similarly, some of the animals taken in the coastal portion of the fishery (see stock assessment report for the Oregon and Washington Coast stock for details) may have been from the inland stock. 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 Inland Washington stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon and Washington Coast stock. However, as noted, 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 1995). Accordingly, Table 1 includes data only from that portion of the northern Washington marine set gillnet fishery occurring within the range of the Inland Washington stock (those waters east of Cape Flattery), where observer coverage ranged from 6 to 80%. Data from 1993-1998 ~~1990-96~~ are included in Table 1, although the mean estimated annual mortality is calculated using the most recent 5 years of available data. As noted above, there was no observer program in 1994, and~~. L~~little effort occurred in the inland portion of the fishery in 1995, 1997, and 1998. ~~observer coverage was lower than usual (24%), and no mortalities were observed. Effort increased in the inland portion of the fishery in 1996 without a concurrent increase in observer coverage (leading to only 6% observer coverage in 1996).~~ No harbor seal mortalities were observed or reported in this fishery from 1995 to 1998 ~~1996~~. The mean estimated mortality for this fishery is 4 ~~9.2~~ (CV=1.0 ~~0.43~~) 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 (WDF&W) 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 (Inland Washington stock) in ~~due to~~ commercial and tribal fisheries ~~from 1990 through 1996 and calculation of the mean annual mortality rate~~ that might take this species; n/a indicates that data are not available. All entanglements resulted in the death of the animal. ~~Data from 1992 to 1996 (or the most recent 5 years of available data) are used in the mortality calculation when more than 5 years of data are provided for a particular fishery.~~ 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	Years	Data type	Percent ~~Range of~~ observer coverage	Observed annual mortality ~~(in given yrs.)~~	Estimated mortality ~~(in given yrs.)~~	Mean annual takes (CV in parentheses) ~~mortality~~
Northern WA marine set gillnet (tribal fishery: inland waters)	~~90-96~~ 93 94 95 96 97 98	obs data	~~6-74%~~ 61% 0% 24% 6% 80% 40%	~~4, 8, 10,~~ 12 n/a 0 0 0 0	~~10, 13, 13,~~ 20 n/a 0 0 0 0	4.0 ~~9.2~~ (~~CV=~~1.0 ~~.43~~)
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) ~~(CV is 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 gill net (areas 7 and 7A)	94	obs data	7%	1	15	15 (~~CV=~~1.0)
~~Observer program total~~						~~34.2~~ ~~(CV is n/a)~~
				Reported mortalities		
WA Puget Sound Region salmon set/drift gillnet	~~90-96~~ 94-98	self reports	n/a	~~13, 43, 22, 16,~~ n/a, n/a, n/a, n/a, n/a	n/a	see text
WA salmon net pens	97-98	self reports	n/a	10, 5	n/a	7.5 (n/a)

Fishery name	Years	Data type	Percent ~~Range of~~ observer coverage	Observed annual mortality ~~(in given yrs.~~)	Estimated mortality ~~(in given yrs.)~~	Mean annual takes (CV in parentheses) ~~mortality~~
unknown Puget Sound fishery	~~90-96~~ 94-98	strand data	n/a	~~2, 0, 0, 3,~~ 3, 0, 2, 1, 1	n/a	1.4 ~~1.6~~ (n/a)
Minimum total annual takes ~~mortality~~						37.9 (0.82) ~~35.8 (CV is n/a)~~

In 1994, NMFS in conjunction with WDF&W 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 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 WDF&W and the Tribes monitored the Puget Sound treaty and non-treaty sockeye salmon gill net 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 (4 ~~9.2~~), Puget Sound non-treaty chum salmon gillnet in areas 10/11 and 12/12B (10), and Puget Sound treaty and non-treaty sockeye salmon gillnet in areas 7 and 7A (15) fisheries results in an estimated minimum annual mortality rate in observed fisheries of 29 ~~34.2~~ harbor seals 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 extrapolations of total kill did not include effort for the unobserved segments of this fishery. Therefore, 29 ~~34.2~~ is an underestimate of the harbor seal mortality due to the entire fishery. It is not possible to quantify what percentage of the Washington Puget Sound Region salmon set/drift gillnet fishery was actually observed in 1994. 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.).

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 1994-1998 ~~1990-96~~ for the Washington Puget Sound Region salmon set and 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 in Washington salmon net pens, 10 in 1997 and 5 in 1998 (Table 1), resulting in an annual mortality of 7.5 harbor seals 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 ~~not available~~ incomplete for 1994, not available for ~~and~~ 1995, and considered unreliable after 1995 ~~for 1996~~ (see Appendix 4 in Hill and DeMaster, 1998 ~~in press~~).

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 ~~1990~~ 1994 to 1998, 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 1994-1998 ~~1992-96~~ result in an estimated annual mortality of 1.4 ~~1.6~~ 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).

~~Though the observer program data underestimates total mortality for this stock, it is considered more reliable than self-reported fishery information. Thus, the self-reports were not used in the fishery mortality rate calculation.~~ The minimum estimated fishery mortality and serious injury for this stock is 37.9 (rounded to 38) ~~36~~ harbor seals per year, based on observer program data (29 ~~34.2~~), fisher self-reports (7.5), and stranding data (1.4 ~~1.6~~). However, a reliable estimate of the total mortality rate incidental to commercial fisheries is currently unavailable due to the absence of observer placements in segments of the Washington Puget Sound Region salmon set and drift gillnet fishery.

Other Mortality

Strandings of harbor seals resulting from collisions with boats, from gunshot injuries, or entangle~~d~~ment in line unrelated to fisheries are another source of mortality data. During the 5-year period from ~~1992~~ 1994 to 1998, ~~1996~~ human-related ~~harbor seal strandings of animals form this stock~~ mortalities occurred ~~in~~ each year, with reports of ~~1, 7,~~ 7, 1, ~~and~~ 8, 7, and 2 animals for those years ~~stranding reports in 1992 through 1996~~, respectively. These mortalities resulted in an estimated annual mortality of ~~4.8 (rounded to~~ 5~~)~~ harbor seals from this stock during 1994-1998 ~~1992-96~~. 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 Northwest Indian tribes have developed, or are in the process of developing, regulations for ceremonial and subsistence harvests of harbor seals 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.

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 (~~36~~ 38+5=43 ~~41~~) does not exceed the PBR (910 ~~966~~). Therefore, the Inland Washington stock of harbor seal is not classified as a strategic stock. At present, the minimum estimated fishery mortality and serious injury for this stock (38 ~~36~~) is less that 10% of the calculated PBR (91) and, therefore, ~~be~~ is considered 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).

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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 Isands 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.

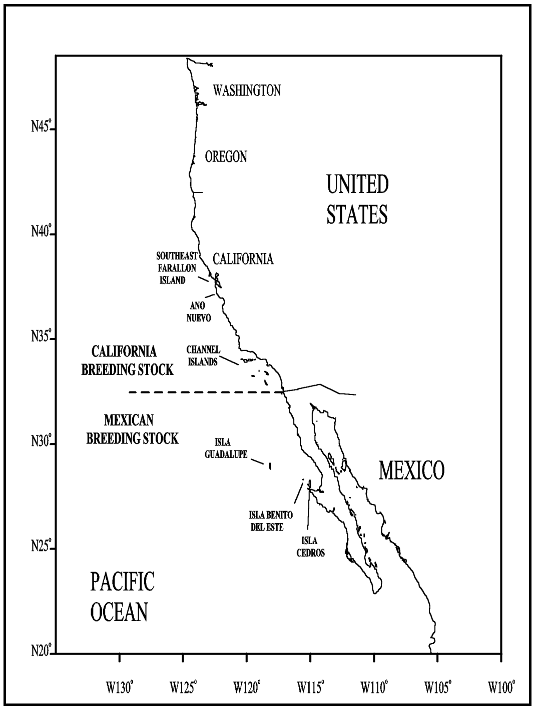

Figure 1. Stock boundary and major rookery areas for northern elephant seals in the U.S. and Mexico.

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 24,000 pups born in California in 1994-96 ~~recent years~~ (Fig. 2) and this 3.5 multiplier, the California stock was approximately 84,000 in 1996.

Minimum Population Estimate

The minimum population size for northern elephant seals can be estimated very conservatively as 51,625, twice the observed pup count (to account for the pups and their mothers) plus the peak number of males and juveniles counted at the Channel Island (Lowry, pers.comm.) and Año Nuevo (Le Boeuf 1996) sites in 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 1994 but appear to be stable or slowly decreasing in Mexico (Stewart et al. 1994). The number of pups born appears

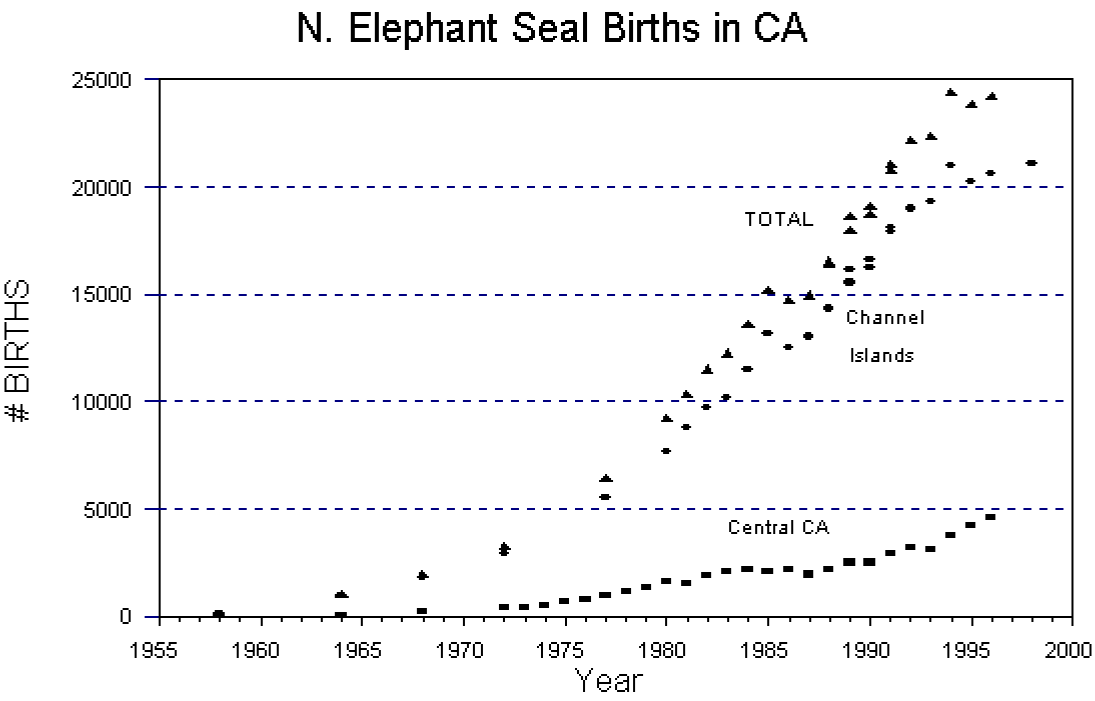

Figure 2. Estimated number of northern elephant seal births in California 1958-98. Multiple independent estimates are presented for the Channel Islands 1988-91. Total and central California counts are not yet available for 1998. Estimates are from Stewart et al. (1994), Lowry et al. (1996), and unpublished data from S. Allen, B. Hatfield, R. Jameson, B. Le Boeuf, M. Lowry, and W. Sydeman.

to be leveling off in California over the last five ~~two~~ years (Fig. 2). More time is required to determine whether the reduction in growth at the California rookeries is temporary (as was observed in 1985) or whether it represents an approach to carrying capacity.

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 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

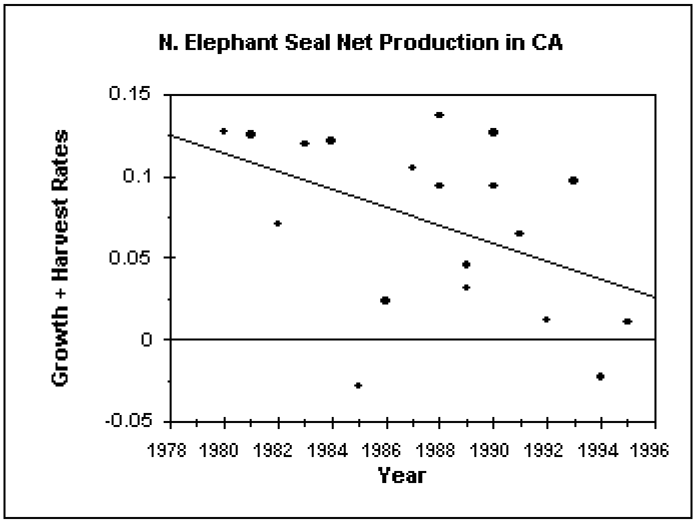

Figure 3. Net production rates for northern elephant seals in California based on pup births and fishery mortality. Annual mortality for 1980-1987 is assumed to be 300, the average of 1988-90 values (Perkins et al. 1994).

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 (51,625) times one half the observed maximum net growth rate for this stock (1/2 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 2,142.

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. Because the set gillnet fishery has undergone dramatic reductions and redistributions of effort and because that fishery has not been observed since 1994, average annual mortality for that fishery cannot be accurately estimated for the recent years (1995-98). Rough estimates for 1995-1998 have been made by extrapolation of prior kill rates using recent effort estimates (Table 1). Preliminary set gillnet observations in Monterey Bay from April to September 1999 included 3 elephant seals in 24.6% of the sets for a rough extrapolated estimate of 12 mortalities in this half-year period. Stranding data reported to the California Marine Mammal Stranding Network in 1995-98 include elephant seal injuries caused by hook-and-line fisheries (2 injuries) and gillnet fisheries (1 injuries). The average estimated annual mortality for northern elephant seals in these

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; Julian and Beeson 1998~~, in press~~; Cameron and Forney 1999; Perez, in prep.; NMFS unpubl. data). n/a indicates information is 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	~~1991~~ ~~1992~~ ~~1993~~ 1994 1995 1996 1997 1998	observer data	~~9.8%~~ ~~13.6%~~ ~~13.4%~~ 17.9% 15.6% 12.4% 22.8% 20.2%	~~13~~ ~~15~~ ~~14~~ 22 14 4 8 4	~~132 (0.25)~~ ~~110 (0.24)~~ ~~105 (0.26)~~ 123 (0.23) 90 (0.25) 37 (0.55) 45 (0.33) 20 (0.44)	33 (0.27)[1] ~~106 (0.11)~~
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	1991 1992 1993 1994 1995 1996 1997 1998	observer data extrapolated estimate	9.8% 12.5% 15.4% 7.7% 0.0% 0.0% 0.0% 0.0%	3 7 11 2 - - - -	30 (0.55) 51 (0.35) 70 (0.27) 16 (0.66) 47 (0.29) [2] 46 (0.23) [2] 60 (0.24) [2] 70 (0.26) [2]	n/a ~~31.5 (0.26) [2]~~
WA, OR, CA groundfish trawl	1991-95	observer data	54-73%	0	0,0,0,0,0	0
WA Willapa Bay drift gillnet fishery (salmon)	1991	personal communication	n/a	2	2	n/a ~~0.4~~
Chehalis River salmon setnet fishery	1993	personal communication	n/a	4	4	n/a ~~1~~
Total annual takes						>33.0 (0.27) ~~145 (0.10)~~

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

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

~~[2] Set gillnet fishing effort was reduced in 1994-95 (Appendix 1); consequently, California set gillnet mortality was averaged for those years only.~~

fisheries for the five most recent years of monitoring (1994-98)~~(1991-95)~~ is likely to be substantially greater than 33 (the number estimated for the drift gillnet fishery alone) but, based on extrapolations from previous years, is not likely to be more than two or three times greater (ie. less than 100). ~~145 (note: only the most recent 2 years are averaged for the CA set gillnet fishery because effort was reduced then by permanent area closures).~~

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 (D. Holts, 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 1995-98: (1) boat collision (1 injury), (2) automobile collision (5 mortalities), and (3) shootings (3 mortalities). 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 ~~rate~~ is much less than the calculated PBR for this stock (2,142), 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 also appears to be ~~(145 animals per year) is~~ 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.

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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 Point Conception, California (and possibly as far north as the Farrallon Islands), to the Revillagigedo Islands, Mexico (Fleischer 1987).~~ Prior to the harvest it ranged from ~~Point Conception, California (and possibly as far north as the Farrallon Islands)~~ 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). ~~At the present time~~ Guadalupe fur seals pup and breed ~~only~~ mainly at ~~Guadalupe Island~~ Isla Guadalupe, Mexico~~; but individuals have been sighted in the Channel Islands and central California (Stewart et al. 1987, Gallo 1994) and in the Gulf of California (Gallo 1994, O.~~ 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 ~~(Gallo 1994, O~~; and as far south as Zihuatanejo, Mexico (17° 39' N, 101° 34'W; Hanni et al. 1997 and Aurioles-Gamboa and Hernadez-Camacho 1999).. ~~Maravilla, pers. comm. 1994).~~ The population is considered to be a single stock because all are recent descendants from one breeding colony ~~. they pup and breed only at Guadalupe Island, Mexico~~ at Isla Guadalupe, Mexico.

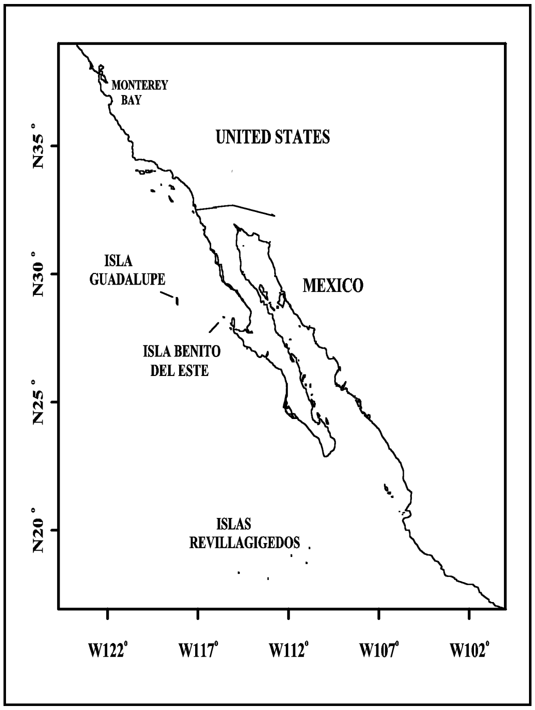

Figure 1. Geographic range of the Guadalupe fur seal, showing location of two rookeries at Isla Guadalupe and Isla Benito Del Este.

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 ~~Size~~ 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 ~~1~~ 2).

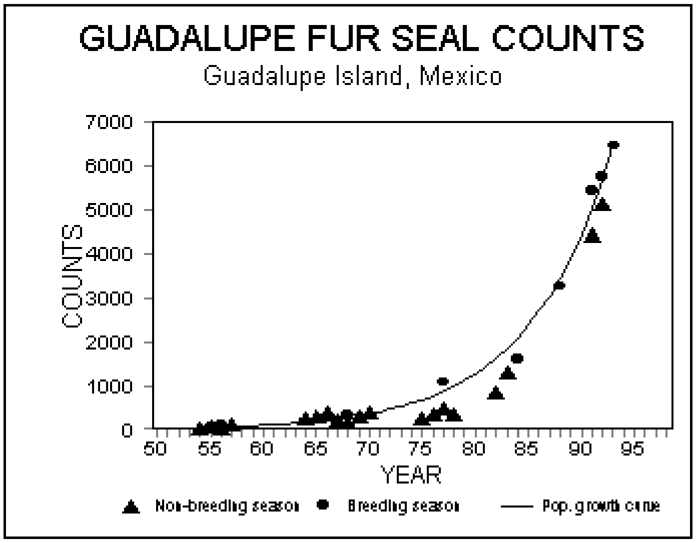

Figure 2. Counts of Guadalupe fur seals at Guadalupe Island, Mexico, and the estimated population growth curve derived from counts made during the breeding season.

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.

~~ANNUAL~~ HUMAN-CAUSED MORTALITY AND SERIOUS INJURY ~~RATE~~

~~Fishery~~ 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 ~~(Lennert et al. 1991, Perkins et al. 1992, Julian et al. 1993, 1994~~). No information is available for human-cause 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. ~~Drift and set gillnet fisheries may cause incidental mortality of Guadalupe fur seals in Mexico and the United States. In the United States, during 1993 there were 134 vessels in the set-gillnet fishery for halibut and angel shark and 149 vessels in the drift-gillnet fishery for shark and swordfish. The number of set net vessels declined in 1994 because the Marine Resources Protection Act of 1990 (passed by the state of California) limits fishing within 3 miles of the coast in southern California. 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, which has increased from two vessels in 1986 to 29 vessels in 1992 (Sosa-Nishizaki et al.~~ 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 1990-93 (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).

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 estimate	7.7% 0% 0% 0% 0%	0 0 0 0 0	0 0 0 0 0	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 overall pinniped cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

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

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.

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Revised ~~12/15/98~~ 01/03/00

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

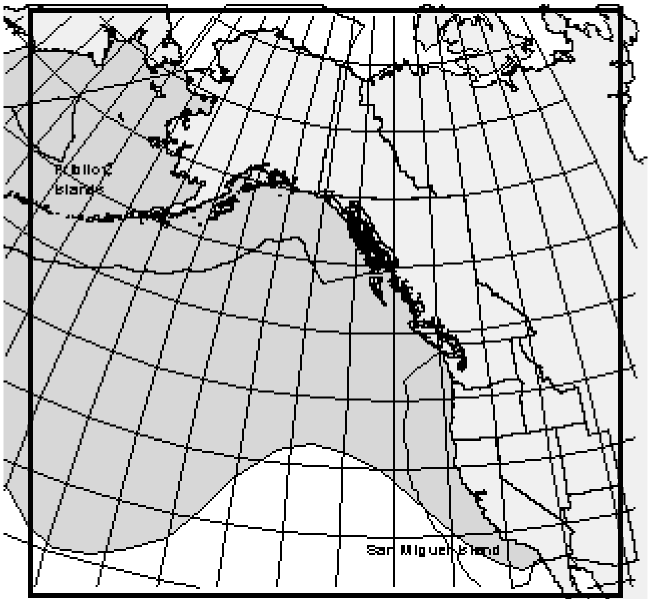

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

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).

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.). ~~The most recent~~ A 1998 pup count ~~occurred in 1997,~~ resulted~~ing~~ in a total count of 627 pups, a 79.6% decrease from the 1997 count of 3,068 ~~3,176~~ (Melin and DeLong in press). In 1999, the population began to recover with a total pup count of 1,084 (S. Melin, unpubl. data ~~NMFS, unpubl. data~~). Based on the 1999 ~~1997~~ count and the expansion factor, the most recent population estimate of the San Miguel Island stock is 4,336 ~~12,704~~ (1,084 ~~3,176~~x4.0) 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 ~~using Equation 1 from the PBR Guidelines (Wade and Angliss 1997)~~. Rather, N_{MIN} is estimated as twice the maximum number of pups born in 1999 ~~1997~~ (to account for the pups and their mothers) plus the maximum number of adult and sub-adult males counted for the 1999 ~~1997~~ season which results in an N_{MIN} of 2,336 ~~6,720~~ ((~~3,176~~ 1,084 x2)+168~~368~~). 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 ~~the early 1970s~~, except for severe declines in 1983 and 1998 associated with ~~during the~~ El Niño Southern Oscillation events in 1982-1983 and 1997-98 (DeLong and Antonelis 1991, Melin and DeLong in press). 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, in press; Melin et al. 1996).

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 1982-83 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). ~~In 1983 the counts decreased dramatically, by 63% (DeLong and Antonelis 1991), and have since steadily increased; yet, counts remained below the 1982 level (pre-El Niño) until 1990 and have increased thereafter (Fig. 2).~~

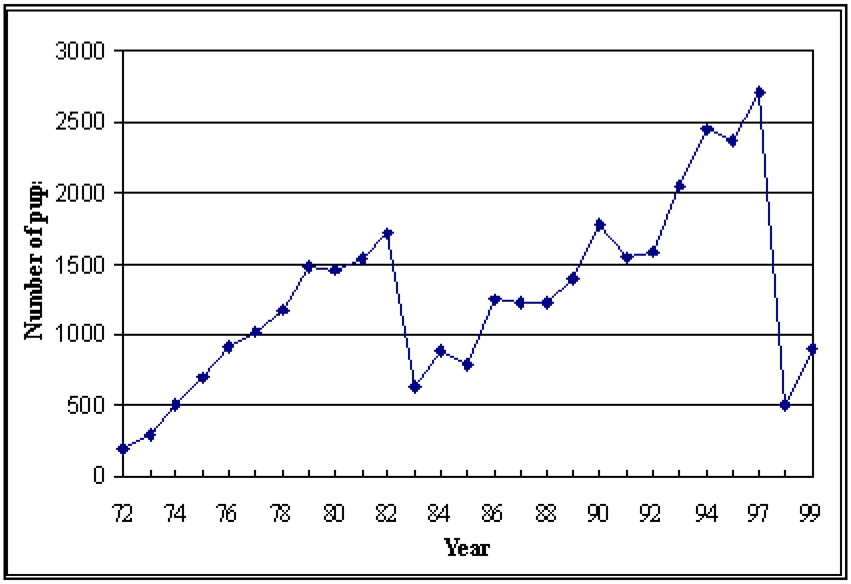

Figure 2. Northern fur seal live pup counts on San Miguel Island, 1972-~~97~~1999. Counts from 1996 were incomplete and have not been included in the figure.

From July 1997 through May 1998, the most severe El Niño event in recorded history affected California coastal waters (Lynn et al. 1998). ~~The~~ In 1997, total fur seal ~~live~~ pup production was 3,068 pups, ~~count of 2,706 was~~ the highest recorded ~~reported at the San Miguel~~ since the colony ~~since~~ has been monitored ~~it was discovered in 1968 (S. Melin, unpubl. data)~~. However, it appears that ~~U~~up to 87% ~~75%~~ 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 in press) ~~within 5 months of birth, and pups surviving to weaning were very emaciated. It is expected there will be no survival of pups from the 1997 cohort (DeLong et al. 1998 at http://nmml.afsc.noaa.gov/el_nino). However, because the San Miguel Island stock is small and located at the southern extent of the species' range, it appears to be more sensitive to environmental fluctuations than the Pribilof Island population and thus experiences greater fluctuations in population trends. The San Miguel Island stock will likely experience increased emigration and pup and adult mortality in 1998 if the predicted El Niño Southern Oscillation event is as strong as the 1982-83 event, which may result in slowed population growth or decline in the next few years.~~ 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 in press).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The northern fur seal population in the Pribilof Islands increased steadily during 1912-24 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 ~~defined~~ as the ~~product of the~~ minimum population estimate (2,336) times one-half the observed maximum ~~theoretical~~ net growth ~~productivity~~ rate (½ of 8.6%) times~~, and~~ a recovery factor~~: PBR = N_{MIN} x 0.5R_{MAX} x F_R. The recovery factor (F_R) for this stock is~~ of 1.0~~, the value~~ (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. ~~Thus, for the San Miguel Island stock of northern fur seals, PBR = 270 animals (6,720 x 0.043 x 1.0).~~

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) ~~1990-96~~. 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 1997-98 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 ~~1990~~ 1994 and 1998 ~~1996~~, there were no fisher self-reports ~~from 2 fisheries (Table 1) reported mortalities~~ of northern fur seals~~.~~ mortalities from any fisheries operating within the range of this stock. ~~The reported mortalities have been included in Table 1 for completeness. However, these mortalities were not used in the mortality rate calculation because there is a reasonable likelihood that the animals had been misidentified and both fisheries were observed during those years without any observed mortalities of northern fur seals. Mortality of northern fur seals incidental to these fisheries, if it occurred, indeed appears minimal.~~ Self-reported fisheries data are incomplete ~~not available~~ for 1994, not available for ~~and~~ 1995, and considered unreliable after 1995 ~~for 1996~~ (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 ~~due to~~ commercial fisheries ~~from 1990 through 1996 and calculation of the mean annual mortality rate~~ that might take this species; n/a indicates that data are not available. 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	**Years**	**Data type**	**Percent ~~Range of~~ observer coverage**	**Observed ~~Reported~~ mortality ~~(in given yrs.)~~**	**Estimated annual mortality ~~(in given yrs.)~~**	**Mean annual takes (CV in parentheses) ~~mortality~~**
CA/OR thresher shark/ ~~and~~ swordfish drift gillnet	~~90-96~~ 94 95 96 97 98	obs data	~~4-18%~~ 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[1]
CA angel shark/halibut set gillnet	~~90-94~~ 90 91 92 93 94	obs data	~~5-15%~~ 5.2% 9.8% 12.5% 15.4% 7.7%	0 0 0 0 0	0 0 0 0 0	0
WA/OR/CA groundfish trawl (Pacific whiting component)	~~90-96~~ 94 95 96 97 98	obs data	~~44-72%~~ 53.8% 56.2% 65.2% 65.7% 77.3%	~~0, 0, 0, 0,~~ 0 0 0 0 0	~~0, 0, 0, 0,~~ 0 0 0 0 0	0
~~Observer program total~~						~~0~~
CA/OR thresher shark/ ~~and~~ swordfish drift gillnet	~~90-96~~ 94-98	self reports	n/a	~~1, 0, 0, 0,~~ n/a, n/a, n/a, n/a, n/a	n/a	-
CA angel shark/halibut set gillnet	~~90-96~~ 94-98	self reports	n/a	~~1, 0, 1, 0,~~ n/a, n/a, n/a, n/a, n/a	n/a	-
unknown west coast fishery	~~90-96~~ 94-98	strand data	n/a	~~2, 0, 0, 0,~~ 0, 0, 0, 0, 0	n/a	0
Minimum total annual takes ~~mortality~~					Total	0

[1] Only 1997-98 mortality estimates are included in the average because overall entanglement rates dropped considerably after a take reduction plan was implemented in 1997.

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, ~~1990-96 the only reported~~ no northern fur seal strandings occurred. ~~in 1990 (Table 1)~~. ~~The strandings could not be attributed to a particular fishery and as a result have been included as unknown west coast fishery.~~ Fishery-related strandings during 1994-1998 ~~1992-96~~ 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 ~~270~~). Therefore, the San Miguel Island stock of northern fur seal 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 ~~has~~ decreased 79.6% from 1997 to 1998 and began to recover in 1999. ~~increased in recent years although~~ Tthe ~~population~~ 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.

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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 populations at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll. Small populations at Necker Island and Nihoa Island are maintained by immigration, and a few seals are distributed throughout the main Hawaiian Islands. Studies of Hawaiian monk seals have focused on their abundance and behavior on land during the reproductive season (spring and summer). Expanded research is underway, but currently the pelagic distribution and behavior of monk seals cannot be fully characterized.

In the last two centuries, the species has experienced two major declines which, presumably, have severely reduced its genetic variation. The tendency for genetic drift may have been (and continue to be) relatively large, due to the small size of different island/atoll populations. However, 10-15% of these seals migrate among the populations (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).

Demographically, the different island populations have exhibited considerable independence. For example, abundance at French Frigate Shoals grew rapidly during the 1950s to the 1980s, while other populations declined rapidly. However, variation in past population trends may be partially explained by changes in the level of human disturbance (Gerrodette and Gilmartin 1990). Current demographic variability among the island populations probably reflects a combination of different recent histories and varying environmental conditions. While research and recovery activities focus on the problems of single island/atoll populations, the species is managed as a single stock.

POPULATION SIZE

Abundance of the main reproductive populations is best estimated using the number of seals identified at each site. Individual seals are identified by applied flipper-tags and bleach-marks, and natural features such as scars and distinctive pelage patterns. Flipper-tagging of weaned pups began in the early 1980s, and the majority of the seals in the main reproductive populations can be identified on the basis of those tags. In ~~1997~~1998, identification efforts were conducted during two- to five-month studies at all main reproductive sites except Midway Atoll, where the study period was ~~10~~12 months. A total of ~~1295~~ 1308 seals (including 246 pups) were observed at the main reproductive populations in ~~1997~~1998 (NMFS, unpubl. data). 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 repeated counts in a single year were last conducted in 1993. Single counts in subsequent years do not indicate abundance at those sites has changed appreciably. The 1993 studies were not of sufficient duration to identify all individuals, so local abundance is best estimated by correcting mean beach counts and assuming that abundance at these sites has not changed. In 1993, mean (±SD) counts (excluding pups) were 22 (±5.2) at Necker Island and 18 (±7.3) at Nihoa Island (Ragen and Finn 1996). The observed 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 number of pups born in 1993) are 65 (±15.1) at Necker Island and 56 (±21.1) at Nihoa Island.

Finally, a small number of seals are distributed throughout the main Hawaiian Islands. These include an unknown number of seals, which naturally occur in the main Hawaiian Islands. In addition, twenty-one seals were released around these islands in 1994. All but two were subsequently resighted near their respective release sites, but their survival to 199~~7~~8 is unknown. Sporadic reports indicate total abundance on the main Hawaiian Islands (including seals released in 1994) may be as high as 40 seals.

Minimum Population Size

The total number of seals identified at the main reproductive sites is the best estimate of minimum population size at those sites (i.e., ~~1295~~ 1308 seals). Minimum population sizes for Necker and Nihoa Islands (based on the formula provided by Wade and Angliss (1997)) are 54 and 41, respectively. If it is (arbitrarily) assumed that the abundance estimate for seals in the main Hawaiian Islands is, say, 40 ±10 seals (i.e., a coefficient of variation of 0.25), then an estimate of the minimum population size in the main Islands is 33 seals. The minimum population size for the entire stock (species) is the sum of these estimates, or ~~1423~~ 1436 seals.

Current Population Trend

Between 1958 and ~~1997~~1998, the total of mean non-pup beach counts at the main reproductive populations declined by 60%. From 1985 to ~~1997~~1998, the rate of decline was ca. ~~4~~3% yr^{-1}, although there has been little change since 1993 (Fig. 1). Further decline is likely, due to extremely high juvenile mortality and an imminent drop in reproductive recruitment in the largest population (French Frigate Shoals).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Assuming mean beach counts are a reliable index of total abundance, then the current net productivity rate for this species is ~~-0.04~~ -0.03 yr^{-1} (loglinear regression of beach counts of non-pups, 1985-9~~7~~8; R^2 = 0.82, P<0.001). This trend is largely due to a catastrophic decline at French Frigate Shoals, where non-pup beach counts decreased by ~~56~~ 60% between 1989 and ~~1997~~1998. Populations at Laysan and Lisianski Islands have not grown, but have remained relatively stable since approximately 1990.

Contrary to trends at the above sites, the population at Kure Atoll has grown at ca. 5% yr^{-1} since 1983 (loglinear regression of beach counts, 1983-9~~7~~8; R^2 = ~~0.75~~ 0.79, P<0.001), due largely to decreased human disturbance and introduced females. The population at Pearl and Hermes Reef has grown at approximately 7% yr^{-1} since 19~~75~~83 (loglinear regression of beach counts, 1975-199~~7~~8; R^2 = ~~0.91~~ 0.81, P<0.001). The latter annual growth rate is the best indicator of the maximum net productivity rate (R$_{max}$) for this species. Finally, the small population at Midway Atoll is showing signs of incipient recovery.

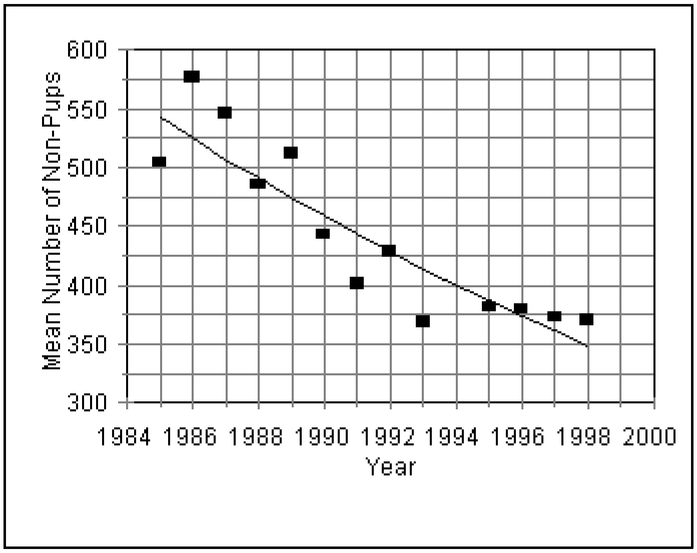

Figure 1. Mean beach counts of Hawaiian monk seals (non-pups) at the main reproductive rookeries (excluding Midway Atoll), 1986-97.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size ~~(1,423)~~ (1,436) times one half the default 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), resulting in a PBR of 5 monk seals per year. However, the Endangered Species Act takes precedence in the management of this species and, under the Act, allowable take is zero.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Human-related mortality has caused two major declines of the Hawaiian monk seal. 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 populations 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 populations 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 caused pregnant females to abandon prime pupping habitat and nursing females to abandon their pups (Kenyon 1972; Gerrodette and Gilmartin 1990). The result was a decrease in pup survival, which led to poor reproductive recruitment, low productivity, and population decline.

~~Since 1979, disturbance from human activities on land has been limited primarily to Kure and Midway Atolls. The U.S. Coast Guard LORAN station at Kure Atoll was closed in 1992 and vacated in 1993. The U.S. Naval Air Facility at Midway was 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. The refuge station and the atoll runway are maintained cooperatively with a commercial aircraft company, which supports its Midway operations, in part, by establishing a tourism center at the site. Strict regulations have been established to prevent further human disturbance of the seals, but careful monitoring of human activities will be essential to ensure that the regulations are both adequate and observed (see Habitat Issues below).~~

~~In addition to disturbance on land, disturbance at sea (e.g., direct and indirect fisheries interactions) may also impede recovery. As described below, however, the possible types of disturbance at sea can not yet be characterized or quantified.~~

Fishery Information

Detrimental fishery interactions with monk seals fall into four categories: operations/gear conflict, entanglement in fisheries debris (most of which likely originate in North Pacific fisheries outside the NWHI), seal consumption of potentially toxic discards, and competition for prey. Since 1982, a total of ~~seven~~ nine fishery-related monk seal deaths have been recorded, including ~~four~~ six from entanglement in fisheries debris (Henderson 1990; NMFS, unpubl. data), one from entanglement in the bridle rope of lobster trap (1986; NMFS, unpubl. data), one from entanglement in an illegally set gill net off the western shore of Oahu (1994; NMFS, unpubl. data), and one from ingestion of a recreational fish hook and probable drowning off the island of Kauai (1995; NMFS, unpubl. data). In addition, ~~16~~17 other seals have been observed with embedded fish hooks, 23 seals have been observed with wounds attributed to interactions with fishing gear, and ~~154~~ 172 cases of seals entangled in fishing gear or other debris have been observed through 1998. 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 ~~studied more thoroughly~~ monitored to assess the rate of fisheries-related injury or mortality for this species.

Four fisheries 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 abundance of slipper lobster have increased in some areas.~~ The number of vessels in the fishery increased from four in 1983 to 17 in 1985, then ~~declined to 9, 12, 0, 5, 1, 5, and 9 in 1991through 1997~~ ranged from 0-12 during 1991-1998, with five vessels participating in 1998 (Dollar 1995; DiNardo et al. 1998; Kawamoto and Pooley, in press). 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, Maro Reef, Gardner Pinnacles, and all remaining banks from Nihoa Island in the east to Kure Atoll in the west (called 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 has been limited to Necker Island and Maro Reef. As a result of the new management approach, 48,100 lobsters comprising 21% of the total catch was taken from Area 4, which had not been fished since the early 1990's (DiNardo et al.1998; Kawamoto and Pooley in press). A significant portion of the Area 4 catch in 1998 was taken at locations where monk seal subpopulations occur. ~~Seasonal and area differences in direct and indirect fisheries interactions remain to be evaluated~~ Neither incidental mortality nor serious injury were observed in ~~1997~~1998. 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. However, the potential for indirect interaction due to competition for prey has not been thoroughly investigated (see Habitat Issues below).

The NWHI bottomfish fishery also interacts with monk seals. This fishery occurred at low levels (< 50 t per year) until 1977, steadily increased to 460 metric tons in 1987, ~~and~~ then dropped to 284 metric tons in 1988, and varied from 137 - 201 metric tons per year from 1989-1998 ~~ca. 140 to 190 t per year from 1988 to 1994~~ (Kawamoto 1995; Kawamoto pers. comm.). ~~During 1995-19978 landings again increased to 384 to 486 t per year (Kawamoto 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 ~~1997~~1998 (Kawamoto 1995; Kawamoto, pers. comm.). 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. Importantly, the State logbook *does not include information on protected species* and, therefore, the nature and extent of interactions with monk seals cannot be reliably assessed. 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 events included seals damaging and removing hooked catch, seals being hooked in the process, and seals consuming discarded fish, which may contain high levels of ciguatoxin or other biotoxins. Mortality rates resulting from hooking or consumption of toxic discards cannot be estimated with the available data. 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.

A third fishery which interacts with monk seals is 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 1991-98. Entry is currently limited to a maximum of ~~167~~ 164 vessels (Ito and Machado, in press). ~~, and 124, 110, 103, and 105 vessels were active in during 1994-1997, respectively (Ito and Machado, in press).~~ Total landings ranged from ~~9,100-13,500~~ 8,100-13,000 metric tons during 1991-~~1997~~ 1998. While much 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 three hooked seals and 13 unusual seal wounds thought to have resulted from interactions. ~~In October 1991, NMFS established a permanent Protected Species Zone extending 50 nautical miles around the NWHI and the corridors between the islands. Subsequent shore-based observations of seals suggest that interactions decreased substantially after establishment of the Protected Species Zone, although they may still be occurring; at French Frigate Shoals in 1994, a parturient female was observed with a hook in her mouth~~. 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.

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	Current est. # of vessels	Date type	Range of observer coverage	Observed mort. (in given years)	Estimated mort. (in given years)	Mean annual mort.
NWHI lobster	91-9~~7~~8	9, 12, 0, 5, 1, 5, 9, 5	Log book	n/a	n/a	n/a	n/a
NWHI Bottomfish	91-9~~7~~8	17, 13, 12, 16, 17, 16, 15~~4~~,14	n/a	n/a	n/a	n/a	n/a
Pelagic longline	91-9~~7~~8	141, 123, 122, 125, 110, 103, 105, 114	Observer Log book	4-5%	0	n/a	n/a
Recreational	91-95	n/a	n/a	n/a	[0,0,0,1,1]†	n/a	n/a

† Data collected incidentally.

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. At least seven other seals have been hooked. Three of these incidents involved hooks used to catch ulua (Caranx spp.). One hooked seal had been translocated from Laysan Island to the main Hawaiian Islands in July 1994. The recent establishment of sport fishing at Midway clearly increases the potential for monk seals to be harmed by hooks at that site.

Fishery Mortality Rate

Because monk seals continue to die as a result of entanglement in fishing debris and data are unavailable to assess interaction with specific fisheries, one must conclude that the total fishery mortality and serious injury for this stock is greater than 1) zero allowable take under the Endangered Species Act and 2) 10% of the calculated PBR. Therefore, total fishery mortality and serious injury can not be considered to be insignificant and approaching a rate of zero.

Importantly, fishery interactions with this species have not been adequately studied and, therefore, the information above represents only the observed level of interactions, not the true level. Without further study, the true level of interaction cannot be estimated. In addition, interactions may be indirect (i.e., involving competition for prey or consumption of discards from the bottom fish fishery) and, to date, the extent or consequences of such indirect interactions have not been evaluated.

Other Mortality

Since 1982, 19 seals have died during rehabilitation efforts, five during research activities, three while held in permanent captivity, and two when captured for translocation.

Seals have also died after encounters with marine debris from sources other than fisheries. 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 population include mobbing, sharks, poisoning by ciguatoxin or other biotoxins, and disease/parasitism. Mobbing occurs when multiple males attempt to mount and mate with an adult female or immature animal of either sex, often leading to the injury or death of the attacked seal. Since 1982, at least ~~64~~66 seals have died or disappeared after being mobbed. The resulting increase in female mortality appears to be a major impediment to recovery at Laysan and Lisianski Islands. ~~It~~ Mobbing has also been documented at French Frigate Shoals, Kure Atoll ~~(although not recently)~~, and Necker Island. The primary cause of mobbing is thought to be an imbalance in the adult sex ratio, with males outnumbering females. In 1994, 22 adult males were removed from Laysan Island, and only ~~one~~ two seals ~~is~~ are thought to have died from mobbing at this site since their removal (1995-9~~7~~8). 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 199~~7~~8, 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 who had been known to kill pups in 1997 were observed exhibiting aggressive behavior toward pups at the beginning of the 1998 pupping season. These two males were translocated to Johnston Atoll, 870 km to the southwest. Subsequently, mounting injury to pups decreased and survival to weaning in 1998 was markedly higher than in 1997.

The incidence of shark-related injury and mortality may have increased in the late 1980s and early 1990s at French Frigate Shoals, but such mortality ~~is~~ was probably not the primary cause of the recent 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. The ~~annual rate and number of shark-related mortalities~~ potential causes of high pup mortality, including shark predation, disease, male aggression and food limitation is currently being investigated at French Frigate Shoals. Poisoning by ciguatoxin or related toxins is suspected as the primary cause of the Laysan die-off in 1978, and may have contributed to the high mortality of juvenile seals translocated to Midway Atoll in 1992 and 1993. While virtually all wild monk seals carry parasites after they begin to forage, the role of parasitism in monk seal mortality is unknown. The effect of disease on monk seal demographic trends is also uncertain.

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 approximately 3~~4~~% per year. Therefore, the Hawaiian monk seal is characterized as a strategic stock.

Habitat Issues

The catastrophic decline at French Frigate Shoals is thought to be related to lack of available prey and subsequent emaciation and starvation. The two leading hypotheses to explain the lack of prey are 1) the local population reached its carrying capacity in the 1970s and 1980s, and essentially diminished its own food supply, and 2) carrying capacity was simultaneously reduced by changes in oceanographic conditions and a resulting decrease in productivity (Polovina et al. 1994; Craig and Ragen in press;). Thus, this population may have significantly exceeded its carrying capacity, leading to a catastrophic increase in juvenile mortality. In addition, available prey also may have been reduced by competition with the NWHI lobster fishery. Monk seals forage at the four main banks where the fishery has primarily operated: Maro Reef, Gardiner Pinnacles, St. Rogatien Bank, and Necker Island. In 1998, the fishery expanded into areas where monk seal breeding populations are concentrated within the fishery's Area 4. Thus, competition for prey merits investigation. This potential for competition cannot yet be evaluated because it is not known if lobster is an important component of the monk seal diet.

A second important habitat issue is the management of human activities at Midway Atoll. Historically, human activities have led to the near extinction of the resident monk seal population at Midway both in the late 1800s, and again in the 1960s. The seal population failed to recover in the 1970s and 1980s, but is finally beginning to show some signs of growth due to immigration from nearby sites. Management jurisdiction of Midway Atoll has been transferred from the U.S. Navy to the Fish and Wildlife Service. The Fish and Wildlife Service maintains a refuge station at Midway Atoll by cooperating with a commercial aircraft company that uses the runway on Sand Island (the largest island at Midway Atoll), and support its operations, in part, by establishing an on-site eco-tourism destination. Tourist activities include a range of land-based and marine recreational activities (e.g., scuba diving and sport fishing), as well as harbor services to visiting vessels. ~~As the tourism venture develops, so does a potential conflict of interest. The economic success of the venture may depend on the nature and variety of human activities or privileges allowed at the site. Importantly, those activities that are intended to enhance the Midway experience may be disruptive or detrimental to the refuge and its wildlife. The issue is whether such potential conflicts can be identified and resolved in a manner that allows for continuation of the ecotourism venture but does not impede monk seal recovery.~~ The Fish and Wildlife Service and NMFS are working cooperatively to ensure that ~~human~~ ecotourism activities do not impede recovery at this ~~important~~ site.

~~An~~ Another important habitat issue is the 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. 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.

A fourth important habitat issue involves entanglement in marine debris ~~as described above. Marine debris is removed from the beaches and entangled seals during annual population assessment activities at the main reproductive sites. Efforts to remove potentially entangling marine debris from the reefs surrounding haulout sites utilized by monk seal have recently begun~~. In 1996, efforts commenced to assess and remove potentially entangling marine debris from reefs surrounding haulout sites utilized by monk seals. Preliminary surveys suggest a very large number of nets are fouled on nearshore reefs in the NWHI, and may pose a serious threat to seals ~~foraging~~ in these areas. During 1996-1998 debris survey and removal efforts, 11,000 kg of derelict net and other debris were removed from coral reefs at French Frigate Shoals and Pearl and Hermes Reef (Boland, pers. comm.). ~~For example, surveys at French Frigate Shoals in 1996 and 1997 found 94 derelict nets per square kilometer of shallow reef area examined (Boland 1997). Extrapolation to total shallow reef area yields an estimate of approximately 30,000 nets at French Frigate Shoals. Efforts to remove nets from monk seal habitat are continuing and will include several cooperating agencies.~~

Recent interest in the harvest of precious coral in the NWHI represents a potential for future interactions with monk seals. The ~~removal of coral and the subsequent~~ impact that removal of precious corals might have on monk seal prey resources and foraging habitat is not ~~currently un~~known. However, recent studies of seals with satellite transmitters and surveys using manned submersibles indicate that some monk seals forage at patches of precious gold corals occurring over 500m in depth (Parrish, pers. comm.). Recruitment of gold coral is very slow (perhaps on the order of 100 years), so there is concern that harvesting could have a long term impact on monk seal foraging habitat.

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HARBOR PORPOISE (*Phocoena phocoena*): Central California 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 are at least nine genetically distinct populations, including two within the present central California stock range (S. Chivers, pers. comm.).

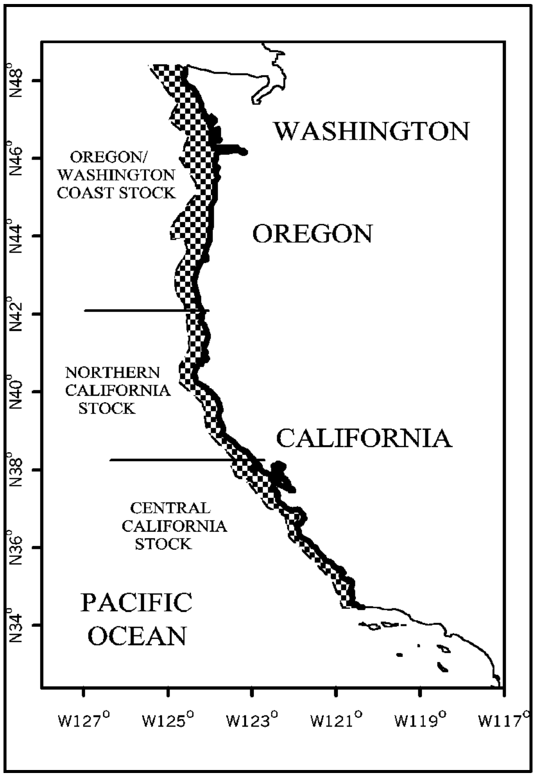


Figure 1. Stock boundaries and distributional range of harbor porpoise along the U.S. west coast. Shaded area bounded by dashed line represents harbor porpoise habitat (0-200 m) along the U.S. west coast.

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. Following the guidance of Barlow and Hanan (1995), we will consider the harbor porpoise in central California as a separate stock. However, based on recent genetic findings (Chivers, pers. comm.), it appears likely that the central California stock will be further subdivided into two stocks (with a division somewhere between Monterey Bay and San Francisco) once the ongoing analyses have been finalized and peer-reviewed. Other U.S. West coast stocks are also likely to be re-evaluated at that time. For the 2000 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, other ~~Other~~ Pacific coast ~~Marine Mammal Protection Act (MMPA) stock assessment reports for~~ harbor porpoise stocks include: 1) a northern California stock 2) an Oregon/Washington coast stock, 3) an Inland Washington stock, 4) a Southeast Alaska stock, 5) a Gulf of Alaska stock, and 6) a Bering Sea stock. Stock assessment reports for northern California and the Oregon and Washington stocks appear in this volume. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

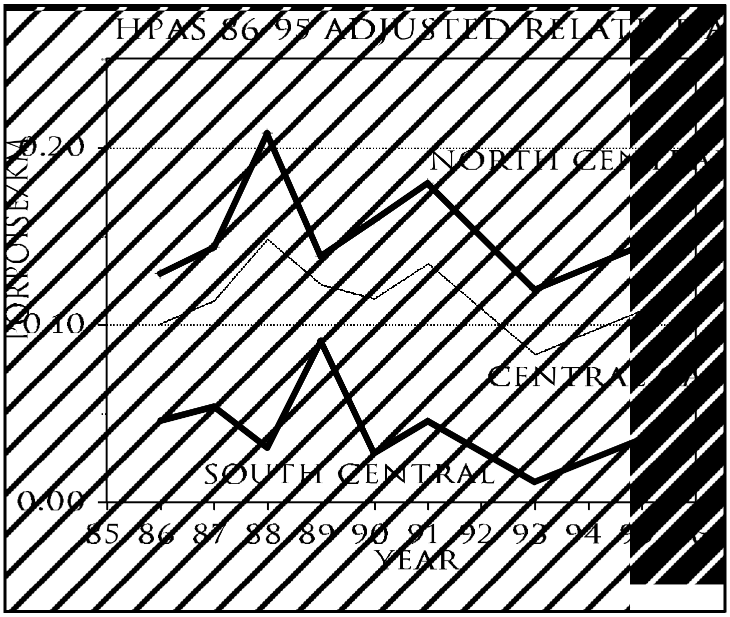
Forney (1999a) estimates the abundance of central California harbor porpoise to be 5,732 (CV=0.39) based on aerial surveys in 1993-97. This estimate is not significantly different from the estimate of 4,120 (CV=0.22) presented by Barlow and Forney (1994). The more recent estimate is ~~higher and~~ less precise, because it was calculated using a more recently developed correction factor for submerged animals (3.42 = 1/g(0) with g(0)=0.292, CV=0.366; Laake et al. 1997); this correction factor is slightly higher than and has a larger estimated variance than the one used by Barlow and Forney (1994; g(0)=0.324, CV=0.173). Both of these estimates only include the region between the coast and the 50-fathom (91m) isobath. Barlow (1988) found that the vast majority of harbor porpoise in California were within this 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). ~~The above abundance estimates are likely to underestimate the total abundance of harbor porpoise by an unknown, but non-trivial amount.~~ 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). Therefore, an unknown number of animals from the central California population may have been in waters deeper than those covered by the surveys in 1993-97, and the above abundance estimate may underestimate the total population size by an unknown amount. Additional aerial surveys are planned in 1999 to cover waters deeper than 50 fathoms (91 m), and the results are expected to shed light on the magnitude of this potential bias.

Minimum Population Estimate

The minimum population estimate for harbor porpoise in central California is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from the 1993-97 aerial surveys (Forney 1999a) or 4,172.

Current Population Trend

Analyses ~~analysis~~ of a 1986-95 time series of aerial surveys ~~was~~ 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 (~~1999b~~ 1995) found a negative trend in population size; however, ~~but~~ 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). ~~not statistically significant (p=0.15) (Figure 2). Between 1986 and 1995, harbor porpoise abundance was negatively correlated with sea surface temperature (Forney 1999b), indicating~~ 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.



~~**Figure 2**. Harbor porpoise relative abundance in central California from 1986-95 aerial surveys (corrected for effects of sea state and cloud cover, Forney 1999b).~~

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. ~~We therefore conclude that the current and maximum net productivity rates are unknown for the central California population of harbor porpoise.~~ Because a reliable estimate of the maximum net productivity rate is not available for central California harbor porpoise, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% (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 (4,172) 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 and a mortality rate $CV \leq 0.30$; Wade and Angliss 1997), resulting in a PBR of 42.

HUMAN-CAUSED MORTALITY

Fishery Information

The incidental capture of harbor porpoise is largely limited to the halibut set gillnet fishery~~ies~~ 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~~ of Barlow et al. (1997)~~. A summary of estimated fishery mortality and injury for this stock of harbor porpoise is given in Table 1~~, based on analyses of entanglement rate data for a 1990-94 observer program (Julian 1997; Julian and Beeson 1998; Cameron 1998,)~~. The mortality estimate for 1994 is based on actual 1994 observer data (Julian and Beeson 1998). At the end of 1994, however, the observer program was discontinued, and mortality estimates for 1995-98 are therefore based on total estimated fishing effort and prior-year entanglement rate data. Forney et al. (in press) evaluated uncertainties in estimating mortality for unobserved years, and presented several alternate analyses of harbor porpoise mortality for this fishery. Their analysis 'C', which includes data from both a 1987-90 California Department of Fish and Game observer program and a 1990-94 National Marine Fisheries Service observer program, best captures the range of variability in entanglement rates and is most consistent with the patterns observed more recently in the 1999 observer program (for which only preliminary results are available at this time; Table 1). Analysis 'C' is also stratified to reflect regional differences in bycatch rates between Monterey Bay and Morro Bay. Table 1 includes the 1995-98 mortality estimates from analysis 'C' in Forney et al. (in press), as was recommended by the Pacific Scientific Review Group at their December 1999 meeting. Although mortality estimates for the most recent five years (1994-98) are presented in Table 1, average annual takes in the setnet fishery are calculated using only 1996-98 data, because fishing effort approximately doubled after 1995, and the majority of recent effort has taken place in the southern areas of Monterey Bay, where very little effort took place prior to 1996.

Table 1. Summary of available information on incidental mortality and injury of harbor porpoise (central CA stock) in commercial fisheries that might take this species (~~Barlow and Hanan 1995; Julian 1997;~~ Julian and Beeson 1998; ~~Cameron 1998,~~ Forney et al., in press; NMFS/SWFSC, unpublished data). Mean annual takes are based on 1994-98 data unless noted otherwise. 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 ~~1993-97~~ (CV in parentheses)
CA angel shark / halibut and other species large mesh (>3.5") set gillnet fishery	~~1993~~		~~15.4%~~	~~2~~	~~13 (0.64)~~	
	1994	observer data	7.7%	1	14 (0.96)	~~24 (0.27)~~
	1995	1987-90 and 1990-94 observer data	0%	-	~~14 (0.64)[1]~~ 42 (0.19)	
	1996		0%	-	~~32 (0.28)[1]~~ 48 (0.19)	
	1997		0%	-	~~49 (0.27)[1]~~ 80 (0.19)	62 (0.19)[1]
	1998		0%	-	57 (0.19)	
	1999	Prelim. 1999 observer data	22.0%	27	approx. 123 (n/a) for Jan-September	
~~**CA set and drift gillnet fishery that use a stretched mesh size of 3.5" or less (white croaker)**~~	~~1980s~~	~~CDFG observer data~~	~~n/a~~	~~1 in 200 sets~~	~~n/a~~	~~n/a~~
Unknown fishery	1994-98	Strandings	-	3 (in 1998)	n/a	≥0.60 (n/a)
Minimum total annual takes						~~24 (0.27)~~ 63 (0.19)

[1] ~~The CA set gillnets were not observed after 1994; mortality was extrapolated from effort estimates and previous entanglement rates.~~ Only 1996-98 mortality estimates are included in the average because of changes in the distribution and amount of fishing effort after 1995 (see text).

The~~se~~ revised mortality data indicate that an average of ~~24~~ 63 harbor porpoise (~~range 13-49,~~ CV=~~0.27~~ 0.19) have been killed each year in ~~all of~~ central California ~~(including both Morro Bay and Monterey Bay regions) each year for~~ during the period ~~1993-1997~~ 1996-98. ~~However, since 1994, there has been a shift in set gillnet effort, with more effort in areas of high harbor porpoise density (Monterey Bay) and less effort in the lower density regions around Morro Bay, where no harbor porpoise mortalities were observed after 1990. Therefore, the mortality estimates presented below (Table 1) may be negatively biased. In a more recent preliminary analysis of mortality using effort and entanglement data only for the Monterey Bay region and including additional 1987-90 entanglement data for the areas presently being fished, Forney (1998) suggests that mortality could be substantially higher. Average annual estimates of mortality for 1993-97 in that study are 107 harbor porpoise (range 49 to 202; CV=0.12) using a stratified analysis, or 99 harbor porpoise (range 62-160, CV=0.19) using an unstratified analysis for the entire Monterey Bay region.~~ An observer program was initiated ~~this area~~ in the Monterey Bay area in April 1999, and ~~more accurate data are expected to be available in the near future~~ the preliminary mortality estimate for January-September 1999 is 123 harbor porpoise (27 mortalities observed in 22% of total effort; NMFS, unpublished data). Thus, it appears that entanglement rates have increased substantially since the early 1990's.

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.

Three fishery-related harbor porpoise strandings were reported in central California in 1998, north of the known set gillnet fishing areas: two near Bodega Head and one inside San Francisco Bay (NMFS, Southwest Region, unpublished data). These mortalities were probably taken from the central California harbor porpoise stock, although it is possible that the northern two animals were taken from the northern California stock and drifted southward to the stranding location. Efforts are underway to identify possible fisheries responsible for these mortalities. 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 ~~rate over the last five years (24~~) for 1996-98 (63 harbor porpoise) is ~~less~~ greater than the calculated PBR (42) for central California harbor porpoise; therefore, the central California harbor porpoise population is ~~not~~ “strategic” under the MMPA. ~~The Pacific Scientific Review Group (established by the MMPA) recommended that this stock be considered strategic because it was thought to be declining. Because the apparent decline in the population is likely to be natural and is no longer statistically significant, the NMFS does not believe that a strategic status is justified at this time.~~ Based on the success of pingers for reducing harbor porpoise mortality in east coast fisheries (Kraus et al. 1997; Trippel et al. 1999), efforts are presently underway to encourage voluntary use of pingers in the central California halibut set gillnet fishery. The observer program is scheduled to continue and will provide information on the success of any voluntary measures. ~~However, this determination should be reviewed after additional mortality data become available at the end of 1999 for the Monterey Bay area set gillnet fishery, because true mortality may be higher than the currently published estimates~~. Research activities will continue to monitor the population size and to investigate population trends. The average gillnet mortality for ~~the last 5~~ 96-98 years (~~24~~ 63 porpoise per year) is greater than ~~10% of~~ the calculated PBR; therefore, the fishery mortality cannot be considered insignificant and approaching zero mortality and serious injury rate. There are no known habitat issues that are of particular concern for this stock.

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Revised ~~09/30/99~~ 01/03/00

HARBOR PORPOISE (*Phocoena phocoena*): Northern California 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 are at least nine genetically distinct populations (S. Chivers, pers. comm.).

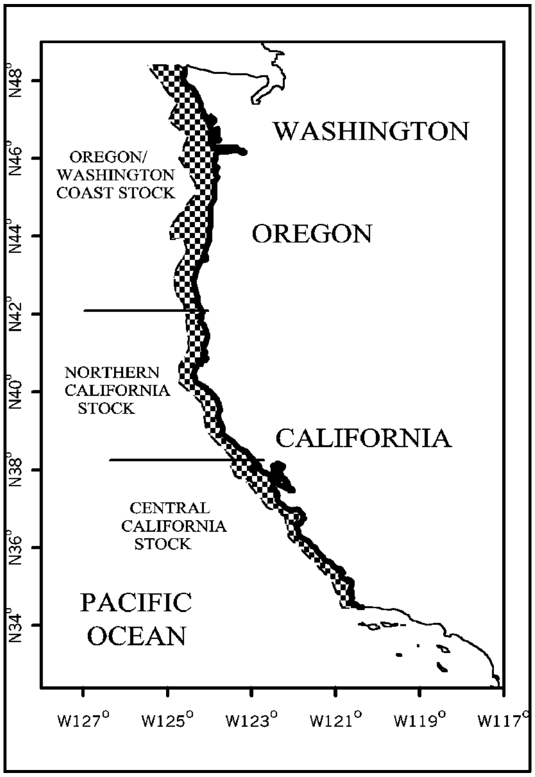

Figure 1. Stock boundaries and distributional range of harbor porpoise along the U.S. west coast. Shaded area bounded by dashed line represents harbor porpoise habitat (0 - 200 m) along the U.S. west coast.

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. Following the guidance of Barlow and Hanan (1995), we will consider the harbor porpoise in northern California as a separate stock. Based on recent genetic findings (Chivers, pers. comm.), U.S. West coast stocks are likely to be re-evaluated once ongoing analyses have been finalized and peer-reviewed. For the 2000 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, other ~~Other~~ Pacific coast ~~Marine Mammal Protection Act (MMPA) stock assessment reports for~~ harbor porpoise stocks include: 1) a central California stock, 2) an Oregon/Washington coast stock, 3) an Inland Washington stock, 4) a Southeast Alaska stock, 5) a Gulf of Alaska stock, and 6) a Bering Sea stock. Stock assessment reports for central California and the Oregon and Washington stocks appear in this volume. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Forney (1999a) estimates the abundance of northern California harbor porpoise to be 11,066 (CV=0.39) based on aerial surveys in 1993-97. This estimate is not significantly different from the estimate of 9,250 (CV=0.23) presented by Barlow and Forney (1994) based on a series of aerial surveys from 1989 to 1993. The more recent estimate is ~~higher and~~ less precise, because it was calculated using a more recently developed correction factor for submerged animals (3.42 = 1/g(0) with g(0)=0.292, CV=0.366; Laake et al. 1997); this correction factor is slightly higher than and has a larger estimated variance than the one used by Barlow and Forney (1994; g(0)=0.324, CV=0.173). Both estimates only include the region between the coast and the 50-fathom (91m) isobath. Barlow (1988) found that the vast majority of harbor porpoise in California were within this 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). ~~The above abundance estimates are likely to underestimate the total abundance of harbor porpoise by an unknown, but non-trivial amount.~~ 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). Therefore, an unknown number of animals from the northern California population may have been in waters deeper than those covered by the surveys in 1993-97, and the above abundance estimate may underestimate the total population size by an unknown amount. Additional aerial surveys are planned for waters deeper than 50 fathoms (91 m) during 1999, and the results may shed light on the magnitude of this potential bias.

Minimum Population Estimate

The minimum population estimate for harbor porpoise in northern California is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from the 1993-97 aerial surveys (Forney 1999a) or 8,061.

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.

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. ~~We therefore conclude that the current and maximum net productivity rates are unknown for the northern California stock of harbor porpoise.~~ Because a reliable estimate of the maximum net productivity rate is not available for northern California harbor porpoise, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% (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 (8,061) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.5~~ 1.0 (for a species ~~of unknown status~~ within its Optimal Sustainable Population; Wade and Angliss 1997), resulting in a PBR of ~~81~~ 161.

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 from stranding reports for the Klamath River tribal salmon gillnet fishery in 1995 (NMFS, Southwest Region, unpublished data). Additionally, 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 central California 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.

~~Fishery Mortality Rates~~

~~Because there is no known fishery mortality in northern California, the fishery mortality can be considered insignificant and approaching zero mortality and serious injury rate.~~

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	1994-98	Stranding reports	n/a	1 (1998)	≥1	≥ 0.2 (n/a)
Minimum total annual takes						≥ 0.2 (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. 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 ~~there is no~~ the known human-caused mortality or serious injury (0.2 harbor porpoise per year) is less than the PBR (161), this stock is not ~~would not be~~ 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.

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Revised ~~09/30/99~~ 01/03/00

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.

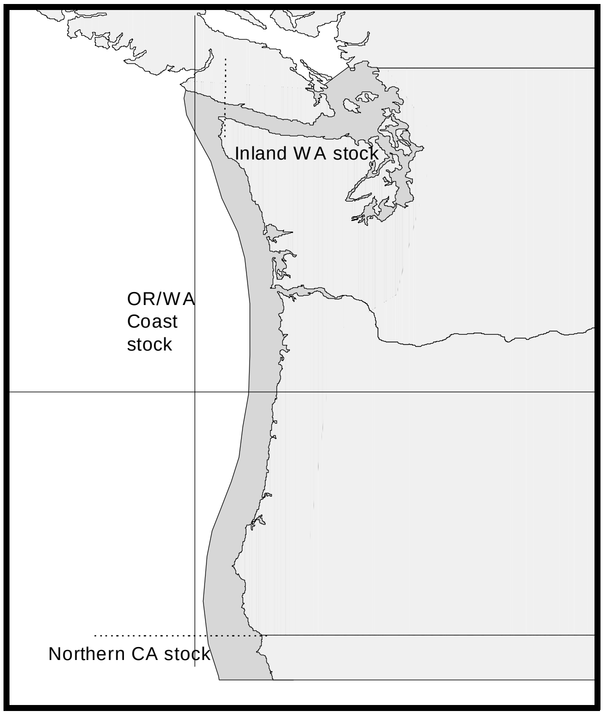

Figure 1. Approximate distribution of harbor porpoise in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the stocks are shown.

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 to occur in Oregon and Washington waters (the Oregon/Washington Coast stock and the Inland Washington stock), with the boundary at Cape Flattery. Recent genetic evidence suggests that porpoise near ~~a population of animals at~~ Spike Rock (on the northern coast of Washington, south of Cape Flattery) are ~~is~~ more similar to the Inland Washington stock of harbor porpoise than to the Oregon/Washington Coast stock (S. Chivers, pers. comm.). All relevant data (e.g., additional 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 the above information four separate harbor porpoise stocks are recognized to occur along the west coast of the continental U.S. (see Fig. 1): 1) the Inland Washington stock, 2) the Oregon/Washington Coast stock, 3) the Northern California stock, and 4) the Central California stock. This report considers only the Oregon/Washington Coast stock, with stock assessment reports for the Inland Washington and both California stocks appearing 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 13,036 (CV=0.11) harbor porpoise in U.S. waters (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 and Washington waters is 44,644 (CV=0.38). This estimate represents a substantial increase over the 1991 estimate of 26,175 (Osmek et al. 1996) 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 44,644 and its associated CV(N) of 0.38, N_{MIN} for the Oregon/Washington Coast stock of harbor porpoise is 32,769.

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

~~Under the 1994 re-authorized Marine Mammal Protection Act (MMPA), the~~ The potential biological removal (PBR) level for this stock calculated ~~is defined~~ as the ~~product of the~~ minimum population ~~estimate~~ size (32,769) times, one half the default maximum ~~theoretical net productivity rate,~~ net growth rate for cetaceans (½ of 4%) times~~and~~ a recovery factor of 0.5 (for a species of unknown status with no known recent fishery mortality; Wade and Angliss1997), resulting in a PBR of 328 harbor porpoise per year.~~: PBR = N_{MIN} × $0.5R_{MAX}$ × F_R. The recovery factor (F_R) for this stock is 0.5, the value for a cetacean stock with an unknown population status (Wade and Angliss 1997). Thus, for the Oregon/Washington Coast stock of harbor porpoise, PBR = 328 animals (32,769 × 0.02 × 0.5).~~

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 1992-93 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.

With the exception of 1994, NMFS observers monitored the northern Washington marine set gillnet fishery during 1993-1998 ~~1992-97~~ (Gearin et al. 1994, 1999; P. Gearin, unpubl. data). For the entire area fished (coastal + inland waters), observer coverage ranged from approximately ~~59~~ 40 to 98% during those years. Fishing effort is conducted within the range of both harbor porpoise stocks (Oregon/Washington Coast and Inland Washington stocks) occurring in Washington State waters. Some of the animals taken in the inland waters portion of the fishery (see stock assessment report for the Inland Washington stock for details) may have been animals from the coastal stock. Similarly, some of the animals taken in the coastal portion of the fishery may have been from the inland stock. 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 Inland Washington 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 porpoises 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 and Washington Coast stock (those waters south and west of Cape Flattery), where observer coverage was ~~ranged from 70-~~100% ~~between 1992 and~~ in 1995-1997. No fishing effort occurred in the coastal portion of the fishery in 1993 or 1998 and, as noted above, no observer program occurred in 1994. Data from ~~1992~~ 1993 to 1998 ~~1997~~ 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 12.4 (CV=0.46) harbor porpoise per year from this stock.

Table 1. Summary of incidental mortality of harbor porpoise (Oregon and Washington Coast stock) ~~due to~~ in commercial and tribal fisheries ~~from 1992 through 1997~~ and calculation of the mean annual mortality rate. Only data from ~~1993~~ 1994 to 1998 ~~1997~~ (or the most recent 5 years of available data) are used to calculate mean annual mortality (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 ~~Range of~~ observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	~~1993-97~~ Mean annual takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery: coastal waters)	~~92-97~~	obs data	~~70-100%~~	~~0,~~	~~0,~~	12.4 (0.46)
	93		no fishery	0	0	
	94		0%	n/a	n/a	
	95		100%	20	20	
	96		100%	29	29	
	97		100%	13	13	
	98		no fishery	0	0	
Observer program total						12.4 (0.46)
Estimated total annual mortality						12.4 (0.46)

The 1995-97~~96~~ 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 1995-96 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, 1999; 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. 1999; 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 ~~1990~~ 1994 and 1998 ~~1997~~, 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. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 4 in Hill and DeMaster 1998).

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

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 (12) does not exceed the PBR (328). Therefore, the Oregon/Washington Coast stock of harbor porpoise is not classified as strategic. The total fishery mortality and serious injury for this stock (12; based on observer data) is not known to exceed 10% of the calculated PBR (33) 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 and population trends is unknown.

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HARBOR PORPOISE (*Phocoena phocoena*): Inland Washington 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.

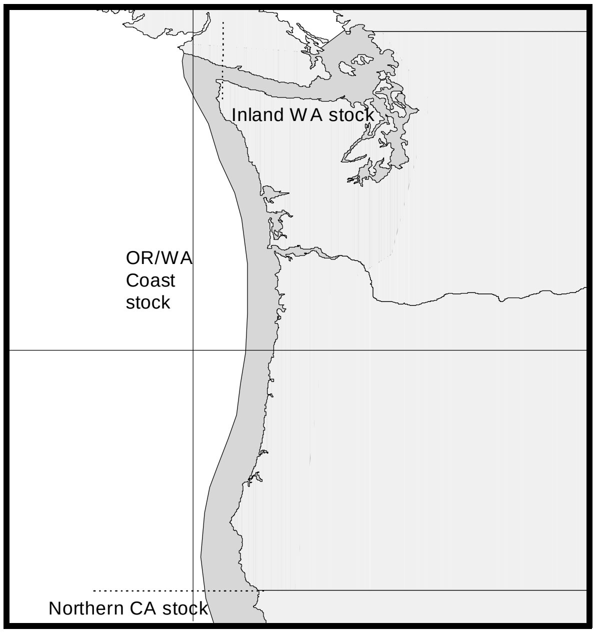

Figure 1. Approximate distribution of harbor porpoise in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the stocks are shown.

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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 to occur in Oregon and Washington waters (the Oregon/Washington Coast stock and the Inland Washington stock), with the boundary at Cape Flattery. Recent genetic evidence suggests that porpoise near ~~a population of animals at~~ Spike Rock (on the northern coast of Washington, south of Cape Flattery) are ~~is~~ more similar to the Inland Washington stock of harbor porpoise than to the Oregon/Washington Coast stock (S. Chivers, pers. comm.). All relevant data (e.g., additional 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 the above information four separate harbor porpoise stocks are recognized to occur along the west coast of the continental U.S. (see Fig. 1): 1) the Inland Washington stock, 2) the Oregon/Washington Coast stock, 3) the Northern California stock, and 4) the Central California stock. This report considers only the Inland Washington stock, with stock assessment reports for the Oregon/Washington Coast and both California stocks appearing 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 Inland Washington 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 Inland Washington 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 Inland Washington 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 Inland Washington 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.

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 Inland Washington harbor porpoise stock.

POTENTIAL BIOLOGICAL REMOVAL

~~Under the 1994 re-authorized Marine Mammal Protection Act (MMPA), the~~ The potential biological removal (PBR) level for this stock is ~~defined~~ calculated as the ~~product of the~~ minimum population ~~estimate~~ size (2,545) times one half the default maximum ~~theoretical~~ net ~~productivity~~ growth rate for cetaceans (½ of 4%) times~~, and~~ a recovery factor of 0.40 (for a species of unknown status and mortality rate CV ≥0.80, Wade and Angliss 1997), resulting in a PBR of 20 harbor porpoise per year. ~~: PBR = N_{MIN} × $0.5R_{MAX}$ × F_R. The recovery factor (F_R) for this stock is 0.4, the value for a cetacean stock with an unknown population status and with a CV of mortality estimates greater than 0.8 (Wade and Angliss 1997). Thus, for the Inland Washington stock of harbor porpoise, PBR = 20 animals (2,545 × 0.02 × 0.4).~~

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

With the exception of 1994, NMFS observers monitored the northern Washington marine set gillnet fishery during 1993-1998 ~~1992-97~~ (Gearin et al. 1994, 1999; P. Gearin, unpubl. data). For the entire area fished (coastal + inland waters), observer coverage ranged from approximately ~~59~~ 40 to 98% during those years. Fishing effort is conducted within the range of both harbor porpoise stocks (Oregon/Washington Coast and Inland Washington stocks) occurring in Washington State waters. Some of the animals taken in the inland waters portion of the fishery may have been animals from the coastal stock. Similarly, some of the animals taken in the coastal portion of the fishery (see stock assessment report for the Oregon/Washington Coast stock for details) may have been from the inland stock. 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 Inland Washington 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 Inland Washington stock (those waters east of Cape Flattery), where observer coverage ranged from 6 to 80% between ~~1992~~ 1993 and 1998 ~~1997~~. Data from 1993-1998 ~~1992-97~~ 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 ~~1992~~ 1993 and 1998 ~~1997~~. As noted above, there was no observer program in 1994, and~~. L~~little effort occurred in the inland portion of the fishery in 1995, 1997, or 1998 ~~and observer coverage was lower than usual (24%). Effort increased in 1996, however, the observer coverage decreased to a low of 6%. In 1997, observer coverage increased to 80%, although little effort occurred.~~ 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 (WDF&W) 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 WDF&W 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 meters of observed gillnets. 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 (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 the WDF&W 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 the animal 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. Though it is not possible to quantify what percentage of the Washington Puget Sound Region salmon set/drift gillnet fishery was actually observed in 1994, 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.). Accordingly, the estimated harbor porpoise mortality (15) appears to be only a slight underestimate for the fishery. See Appendix 1 ~~of Barlow et al. (1997)~~ for additional information~~, including a map depicting fishing areas,~~ regarding the Washington Puget Sound Region salmon set/drift gillnet fishery.

Table 1. Summary of incidental mortality of harbor porpoise (Inland Washington stock) due to commercial and tribal fisheries ~~from 1992 through 1997~~ and calculation of the mean annual mortality rate. Only data from ~~1993~~ 1994 to 1998 ~~1997~~ (or the most recent 5 years of available data) are used to calculate mean annual mortality (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 ~~Range of~~ observer coverage**	**Observed mortality (in given yrs.)**	**Estimated mortality (in given yrs.)**	**~~1993-97~~ Mean annual takes (CV in parentheses)**
Northern WA marine set gillnet (tribal fishery: inland waters)	~~92-97~~ 93 94 95 96 97 98	obs data	~~6-80%~~ 61% 0% 24% 6% 80% 40%	~~0,~~ 0 n/a 0 0 0 0	~~0,~~ 0 n/a 0 0 0 0	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%	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 (areas12,12B, 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 gill net (areas 7 and 7A)	94	obs data	7%	1	15	15 (1.0)
Observer program total						15 (1.0)
				Reported mortalities		
WA Puget Sound Region salmon set/drift gillnet	~~90-97~~ 93-98	self reports	n/a	~~6, 4, 6, 2,~~ n/a, n/a, n/a, n/a, n/a	n/a	see text
Minimum total annual mortality						≥15 (1.0)

An additional source of information on the number of harbor porpoises 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 fishery self-reports of any harbor porpoise mortalities from ~~Self-reported fishery data from 1990 to 1997 for~~ the Washington Puget Sound Region salmon set and drift gillnet fishery ~~are shown in~~ (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. 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). ~~Though the 1994 observer program data may underestimate the total fishery mortality for this stock, it is considered more reliable than the self-reported data. Thus, the self-reported fisheries data were not used in the mortality rate calculation.~~

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. ~~During the period from 1992 to 1997 the only reported~~ No fishery-related strandings of harbor porpoise occurred during 1994-1998 ~~in 1992 (1 animal) and 1993 (1 animal). The mortalities likely occurred in the Washington Puget Sound Region salmon set and drift gillnet fishery. As the 1994 observer program already accounts for 15 harbor porpoise mortalities per year from this fishery, these strandings have not been included in Table 1.~~

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.

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) is not known to exceed the PBR (20). Therefore, the Inland Washington harbor porpoise stock is not classified as strategic. The minimum total fishery mortality and serious injury for this stock (15) 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 and population trends is unknown, although harbor porpoise sightings in the 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 (i.e., one additional observed mortality or serious injury in the area 7/7A sockeye drift gillnet fishery would increase the estimated annual take level above 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 and gillnet fishery.

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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 ~~recent~~ 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.

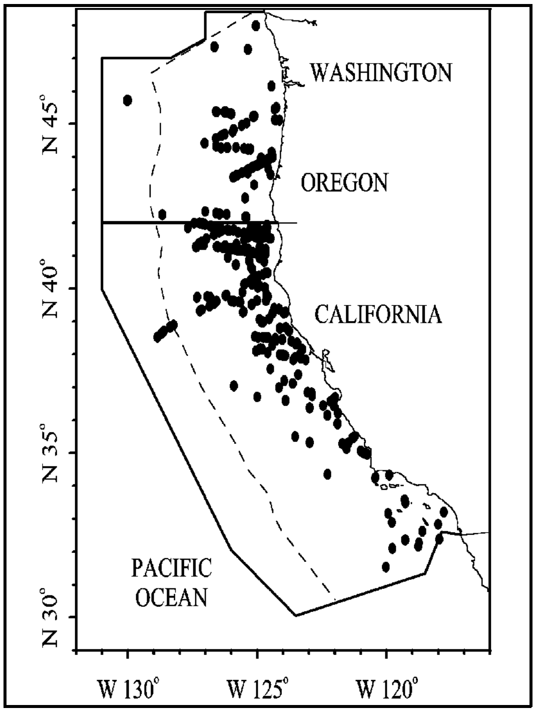

Figure 1. Dall's porpoise sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-94~~ 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer 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). ~~Separate surveys have been conducted during different years off California and Oregon/Washington (Green et al. 1992, 1993; Mangels and Gerrodette 1994; Barlow 1995), but because animals are likely to have moved from one region to another between surveys, the different estimates cannot be added to produce a total estimate. Forney (1994) reviews recent abundance estimates for Dall's porpoise along the U.S. west coast and concludes that the abundance estimate obtained from a 1991 survey in California (Barlow 1995) is the best estimate of overall population size in California, Oregon and Washington. More recently, Barlow and Gerrodette (1996) have combined data from this 1991 survey with those from a similar survey in 1993, yielding an updated abundance estimate of 47,661 (CV = 0.40) Dall's porpoise.~~ 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 ~~above~~ 1991-96 weighted average abundance estimate for both the outer coast of California, Oregon and Washington and inland Washington waters is ~~34,393~~ 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

~~Based on this stock's unknown status and growth rate and given the precision of the estimate of annual fishery mortality (CV=0.52), the recovery factor (F_r) is 0.48. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 34,393 yields a potential biological removal (PBR) of 330 Dall's porpoise per year.~~ 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 ≤0.80; Wade and Angliss 1997), resulting in a PBR of 737 Dall’s porpoise per year.

~~ANNUAL~~ 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). ~~In the California drift gillnet fishery, the observed average rate of kill for Dall’s porpoise for the five most recent years of monitoring, 1991-95, was 15/3,125 = 0.0048 porpoise per fishing day, or one porpoise every 208 fishing days (Julian and Beeson in press).~~ 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. ~~The average estimated annual mortality for Dall's porpoise in this fishery in 1991-95 is 22 (CV=0.52) animals.~~

~~Similar d~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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 ~~1989~~ 1994 and ~~1996~~ 1998, with 54%-77% of the fishing effort observed, ~~four~~ five Dall’s porpoise were reported killed in ~~these fisheries~~ the at-sea processing portion of the Pacific whiting trawl fishery ~~during 2993 observed fishing days~~, and five animals were reported in unmonitored hauls.~~, yielding an incidental catch rate of 0.001337 Dall’s porpoise per fishing day, or one porpoise every 748 fishing days~~. Based only on the systematically observed hauls, ~~total annual~~ Dall’s porpoise mortality was estimated to be ~~about one porpoise in 1992 (CV=0.52;~~ 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. ~~Four additional Dall’s porpoise were reported killed in the California/Oregon/Washington joint venture groundfish trawl fisheries in 1989-90, but no overall estimate of mortality could be calculated because total fishing effort is unknown (Perez, in prep). The joint venture fisheries were discontinued after 1990.~~

~~Based on logbook data, additional mortality of Dall's porpoise is known to occur in the following two fisheries (NMFS, unpublished data): (1) the California salmon troll fishery, and (2) the Washington Puget Sound salmon set and drift gillnet fishery. Due to the uncertainties in these data sources, no estimate of overall mortality can be made for these fisheries, but minimum values based on the reported mortality are presented in Table~~

~~An experimental gillnet fishery for thresher shark off Oregon and Washington in 1986-88 also reported mortality of Dall's porpoise; however, this fishery was discontinued after 1988 due to the high rates of marine mammal and turtle bycatch (Stick and Hreha, 1989).~~

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 ~~1991-95~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~1991~~	~~9.8%~~	~~2~~	~~20 (0.67)~~	
		~~1992~~	~~13.6%~~	~~1~~	~~7 (0.92)~~	
		~~1993~~	~~13.4%~~	~~9~~	~~67 (0.44)~~	~~22 (0.52)~~
		1994	17.9%	2	11 (0.64)	
		1995	15.6%	1	6 (0.92)	
		1996	12.4%	2	24 (0.68)	10 (0.95)[1]
		1997	23.0%	4	20 (0.95)	
		1998	20.0%	0	0	
WA/OR/CA domestic groundfish trawl fisheries (At-sea processing Pacific whiting fishery only).	observer data	~~1991~~	~~53.9%~~	~~0~~	~~0~~	
		~~1992~~	~~72.6%~~	~~1~~	~~1 (0.52)~~	
		~~1993~~	~~65.8%~~	~~0~~	~~0~~	
		1994	53.8%	0	0	
		1995	56.2%	0	0	
		1996	~~66.0~~ 65.2%	0	0	1.6 (0.23)
		1997	65.7%	3	5 (0.44)	
		1998	77.3%	2	3 (0.33)	
	~~other records~~					
	unmonitored hauls	1994		2		
		1996		1	~~n/a~~	0.6 (n/a)
		1997		2		~~n/a~~
~~**WA/OR/CA joint venture groundfish trawl fisheries**~~	~~observer data~~	~~1989-90~~		~~4~~	~~min. 2~~	~~0 (Fishery discontinued)~~
~~**CA/OR/WA salmon troll fishery**~~	~~logbook data~~	~~1990-92~~		~~1~~	~~min. 0.3~~	~~n/a~~
~~**WA Puget Sound Region salmon drift gillnet fishery**~~	~~logbook data~~	~~1990-92~~		~~6~~	~~min. 2~~	~~n/a~~
~~**OR experimental thresher shark gillnet fishery**~~	~~observer data~~	~~1986-88~~	~~10.3%~~	~~4~~	~~approx. 13~~	~~0 (Fishery discontinued)~~
	~~logbook data~~	~~1986-88~~		~~1~~		
Minimum total annual takes ~~1991-95~~						~~22 (CV=0.52)~~ 12 (CV=0.79)

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[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.

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), ~~Because~~ the average annual human-caused mortality in ~~1991-95 (22 animals)~~ 1994-98 (12 animals) is estimated to be less than the PBR (~~330~~ 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.

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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 ~~preliminary~~ 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. ~~1996~~ 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. ~~1996~~ 1997).

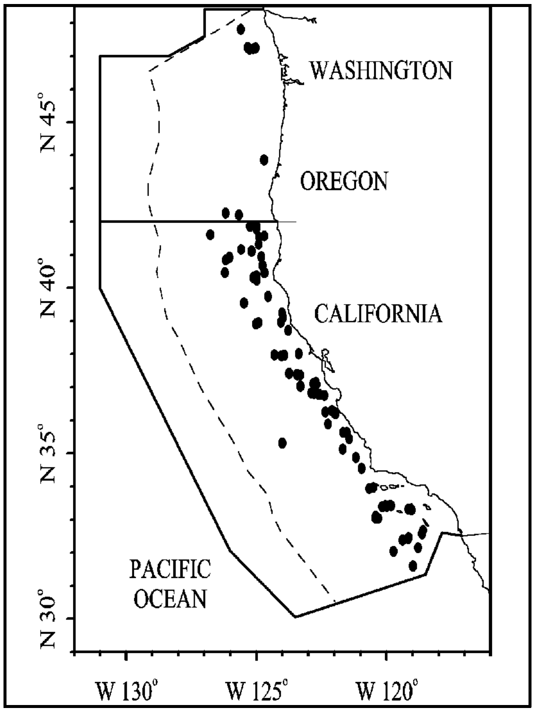

Figure 1. Pacific white-sided dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-94~~ 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates 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

~~Forney (1994) reviews recent abundance estimates for Pacific white-sided dolphins along the U.S. west coast and concludes that the best estimate of overall population size in California, Oregon and Washington is the estimate obtained from aerial surveys conducted off California during winter/spring of 1991 and 1992 (Forney et al. 1995). Because of the observed seasonal shifts in distribution, this estimate of 121,693 animals (CV = 0.48) is expected to~~

~~include animals which may be found off Oregon and Washington in the summer/fall. After completion of analyses for a comprehensive shipboard survey conducted along the entire coast of California, Oregon and Washington in the summer of 1996 (NMFS, Southwest Fisheries Science Center), a summer abundance estimate for the entire defined stock range will be available.~~ 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 ~~above~~ 1991-96 weighted average abundance estimate is ~~82,939~~ 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

~~Based on this stock's unknown status and growth rate and given the precision of the estimate of annual fishery mortality (CV=0.34), the recovery factor (F~~$_r$~~) is 0.48. ½R~~$_{max}$ ~~is the default value of 0.02. Multiplying these two values times the minimum population estimate of 82,939 yields a potential biological removal (PBR) of 796 Pacific white-sided dolphins per year.~~ 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 ≥ 0.60 and ≤ 0.80; Wade and Angliss 1997), resulting in a PBR of 157 Pacific white-sided dolphins per year.

~~ANNUAL~~ 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. ~~In the California drift gillnet fishery, the observed average rate of kill for Pacific white-sided dolphins for the five most recent years of monitoring, 1991-95, is 14/3,125 = 0.0045 dolphins per fishing day, or one dolphin every 223 fishing days (Julian and Beeson in press).~~ 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. ~~The average estimated annual mortality for Pacific white-sided dolphins in this fishery in 1991-95 is 22 (CV=0.34) animals.~~

~~Similar d~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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 ~~1991-95~~ (CV in parentheses)**
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~1991~~	~~9.8%~~	~~5~~	~~51 (0.63)~~	
		~~1992~~	~~13.6%~~	~~3~~	~~22 (0.70)~~	~~22 (0.34)~~
		~~1993~~	~~13.4%~~	~~2~~	~~15 (0.66)~~	
		1994	17.9%	3	17 (0.67)	
		1995	15.6%	1	6 (0.92)	6.0 (0.68)[1]
		1996	12.4%	3	25 (0.96)	
		1997	23.0%	3	12 (0.68)	
		1998	20.0%	0	0	
WA/OR/CA domestic groundfish trawl fisheries (At-sea processing Pacific whiting fishery only).	observer data	~~1991~~	~~53.9%~~	~~0~~	~~0~~	
		~~1992~~	~~72.6%~~	~~0~~	~~0~~	
		~~1993~~	~~65.8%~~	~~0~~	~~0~~	
		1994	53.8%	0	0	
		1995	56.2%	0	0	
		1996	~~66.0~~ 65.2%	0	0	~~n/a~~
		1997	65.7%	0	0	
		1998	77.3%	1	1 (0.48)	0.2 (0.48)
	other records	1996		3	~~n/a~~≥3	0.6 (n/a)
~~**WA/OR/CA joint venture groundfish trawl fisheries**~~	~~observer data~~	~~1989-90~~		~~8~~	~~n/a~~	~~0~~ ~~(Fishery discontinued)~~
~~**OR experimental thresher shark gillnet fishery**~~	~~observer data~~	~~1986-88~~	~~10.3%~~	~~9~~	~~approx. 29~~	~~0~~ ~~(Fishery discontinued)~~
	~~logbook data~~	~~1986-88~~		~~3~~		
Minimum total annual takes ~~1991-95~~						~~22 (0.34)~~ 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 ~~1989~~ 1994 and ~~1996~~ 1998, with 54%-77% of the fishing effort observed, ~~three~~ one Pacific white-sided dolphin~~s were~~ was reported killed in ~~these fisheries~~ the at-sea processing portion of the Pacific whiting trawl fishery, ~~during 2993 observed fishing days~~ and three additional animals were reported in unmonitored hauls.~~, yielding an incidental catch rate of 0.001 dolphins per fishing day, or one dolphin every 998 fishing days. However, none of these animals were observed killed in the systematically observed hauls, and therefore no overall annual estimate of mortality for Pacific white-sided dolphins is available for this fishery. Eight additional Pacific white-sided dolphins were reported killed in the California/Oregon/Washington joint venture groundfish trawl fisheries in 1989-90, but no overall estimate of mortality could be calculated because total fishing effort is unknown (Perez, in prep). The joint venture fisheries were~~

~~discontinued after 1990.~~ 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.

~~An experimental gillnet fishery for thresher shark off Oregon and Washington in 1986-88 also reported mortality of Pacific white-sided dolphins; however, this fishery was discontinued after 1988 due to the high rates of marine mammal and turtle bycatch (Stick and Hreha, 1989).~~

Other removals

Additional removals of Pacific white-sided dolphins from the wild have occurred in live-capture fisheries off California. Brownell et al. (~~in press~~ 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. ~~They are not classified as a "strategic" stock under the MMPA, because the average annual human-caused mortality in 1991-95 (22 animals) is estimated to be less than the PBR (796).~~ 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 ~~during 1991-95~~ is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

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Revised ~~08/01/97~~ 01/03/00

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.

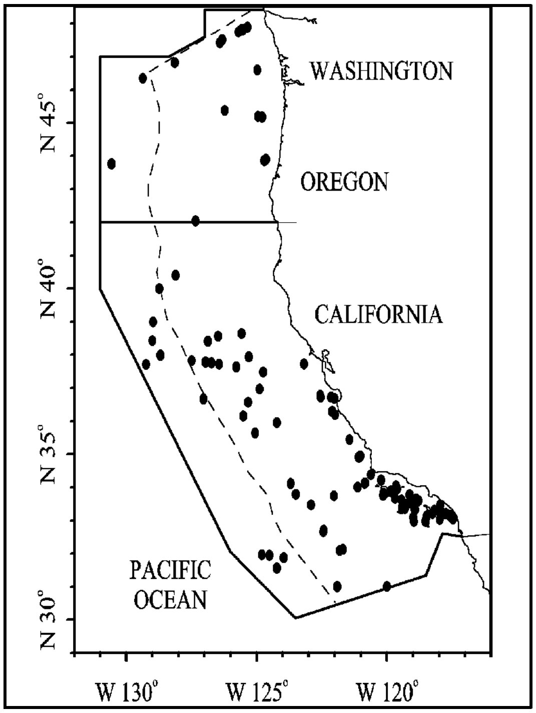

Figure 1. Risso's dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-94~~ 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

~~Forney (1994) reviews recent abundance estimates for Risso's dolphins along the U.S. west coast and concludes that the best estimate of overall population size in California, Oregon and Washington is the estimate obtained from aerial surveys conducted off California during winter/spring of 1991 and 1992 (Forney et al. 1995). Because of the observed seasonal shifts in distribution, this estimate of 32,376 animals (CV = 0.46) is expected to include animals which may be found off Oregon and Washington in the summer/fall. After completion of analyses for a comprehensive shipboard survey conducted along the entire coast of California, Oregon and Washington in the summer of 1996 (NMFS, Southwest Fisheries Science Center), a summer abundance estimate for the entire defined stock range will be available.~~ 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 ~~above~~ 1991-96 weighted average abundance estimate is ~~22,388~~ 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

~~Based on this stock's unknown status and growth rate and given the precision of the estimate of annual fishery mortality (CV=0.22), the recovery factor (F_r) is 0.5. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 22,388 yields a potential biological removal (PBR) of 224 Risso's dolphins per year.~~ 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.

~~ANNUAL~~ 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. In the California drift gillnet fishery, the observed average ~~rate of kill~~ for Risso's dolphins for the most recent five years of monitoring, ~~1991-95, is 24/3,125 = 0.0077 dolphins per fishing day, or one dolphin every 130 fishing days (Julian and Beeson, in press).~~ 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. ~~The average estimated annual mortality for Risso's dolphins in this fishery in 1991-95, is 37 (CV=0.22) animals.~~

~~Similar d~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and ~~may~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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.).

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.

~~An experimental gillnet fishery for thresher shark off Oregon and Washington in 1986-88 also reported mortality of Risso's dolphins; however, this fishery was discontinued after 1988 due to the high rates of marine mammal and turtle bycatch (Stick and Hreha, 1989).~~

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 ~~1991-95~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~1991~~	~~9.8%~~	~~5~~	~~51 (0.50)~~	
		~~1992~~	~~13.6%~~	~~5~~	~~37 (0.48)~~	~~37 (0.22)~~
		~~1993~~	~~13.4%~~	~~7~~	~~52 (0.51)~~	
		1994	17.9%	1	6 (0.91)	
		1995	15.6%	6	39 (0.57)	
		1996	12.4%	0	0	5.5 (0.96) [1]
		1997	23.0%	3	11 (0.96)	
		1998	20.0%	0	0	
~~**CA squid purse seine fishery**~~	~~strandings~~	~~1988-89~~		~~4~~	~~n/a~~	~~n/a~~
~~**OR experim. thresher shark gillnet fishery**~~	~~observer data~~	~~1986-88~~	~~10.3%~~	~~4~~	~~approx. 13~~	~~0 (Fishery discontinued)~~
Minimum total annual takes ~~1991-95~~						~~37 (0.22)~~ 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.

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. ~~The average annual human-caused mortality in 1991-95 (37 animals) is estimated to be less than the PBR (224), so they are not classified as a "strategic" stock 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 ~~during 1991-95~~ is ~~greater~~ less than 10% of the calculated PBR and, therefore, can~~not~~ be considered to be insignificant and approaching zero mortality and serious injury rate.

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Revised ~~08/01/97~~ 01/03/00

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; ~~NMFS, unpublished data~~; Carretta et al. 1998; Defran and Weller 1999) primarily from Point Conception south into Mexican waters, at least as far south as Ensenada. 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 (~~Defran et al. 1986;~~ 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. ~~in prep.~~ 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.

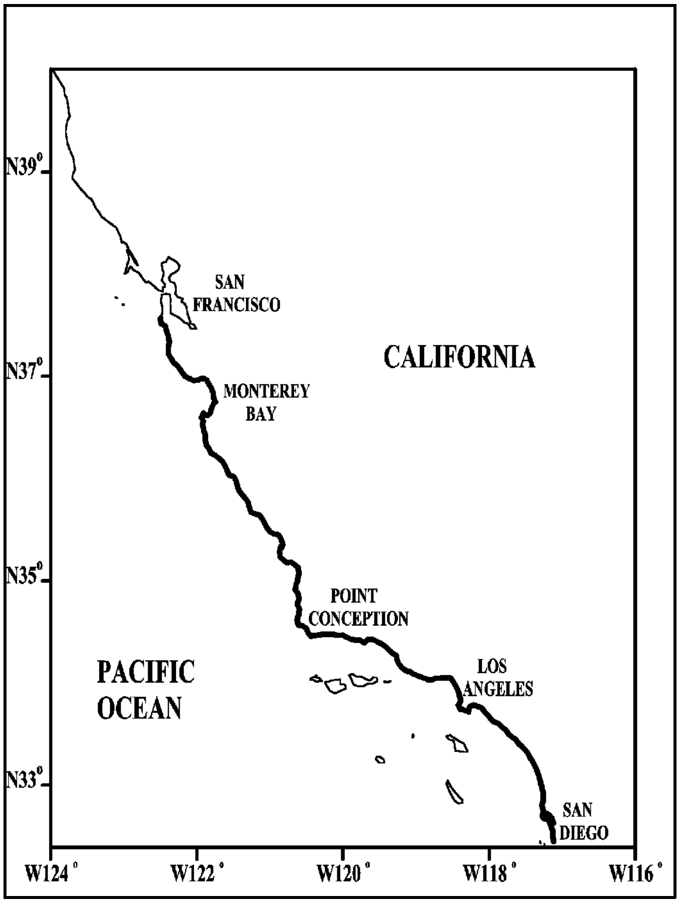

Figure 1. Range (in bold) of the coastal bottlenose dolphin based on aerial surveys along the coast of California from 1990-9~~4~~9 (see Appendix 2, Figure 7, for data sources and information on timing and ~~location~~ distribution of survey effort). This population of bottlenose dolphins is found within 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). 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 to estimate the abundance of coastal bottlenose dolphins throughout the southern California portion of their U.S. range. (Carretta et al. 1998). ~~A recent analysis of a series of replicate aerial surveys conducted in 1990-1994 along the southern California coast (Carretta et al., in prep.) has provided the most current abundance estimates for California coastal bottlenose dolphins.~~ These estimates, which are corrected for the fraction of animals missed by a single observer team, range from 78 to 271 animals, with a mean abundance estimate of 140 bottlenose dolphins (CV = 0.05). ~~However, they are based only on southern California coastal waters, and therefore underestimate the total abundance by an unknown amount, depending on the number of animals that were north of Point Conception at the time of the surveys. A single replicate survey resulted in an additional estimated 44 animals between Point Conception and northern Monterey Bay, but the number of animals in this central California region is likely to be variable (as is the number south of there), so it is not appropriate to add this value to the mean abundance. Furthermore, oceanographic events appear to influence the distribution of animals along the coasts of California and Baja California, 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).~~ These surveys did not include the central California portion of this stock's range, and therefore the published abundances underestimate the total number of animals is U.S. waters by an unknown amount. More recently, two surveys were conducted in 1994 and 1999, covering virtually the entire U.S. range of this species, from the U.S./Mexican border to just south of San Francisco, California. Using the same methods and correction factors as in Carretta et al. (1998), the weighted average abundance estimate for these two surveys is 169 (CV=0.11) 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. ~~Future replicate surveys including both southern California and central California are planned to obtain better abundance estimates for the entire U.S. range of this stock. Because this species is not restricted to U.S. waters and is subject to unknown levels of fishery-related mortality in Mexico, U.S. management is based on the average number of bottlenose dolphins estimated to be in U.S. waters, or 140 animals.~~

Minimum Population Estimate

The log-normal 20th percentile of the above average abundance estimate for U.S. waters based on the 1994 and 1999 surveys ~~(Carretta et al., in prep)~~ is ~~134~~ 154 coastal bottlenose dolphins.

Current Population Trend

No trend in abundance of coastal bottlenose dolphins is apparent based on the available data.

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

~~Based on this stock's unknown status and growth rate, the recovery factor (F_r) is 0.5, and ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 134 yields a potential biological removal (PBR) of 1.3 animals per year.~~ The potential biological removal (PBR) level for this stock is calculated as the minimum population size (154) 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 1.5 coastal bottlenose dolphins per year.

~~ANNUAL~~ 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 ~~known~~ information on fishery mortality and injury for this stock of bottlenose dolphin is shown in Table 1. More detailed information on ~~these fisheries~~ the set gillnet fishery is provided in Appendix 1. ~~Because observer coverage in the set gillnet fishery was not 100% (Julian and Beeson, in press), it is not known if any animals were actually taken, but mortality is unlikely to have been more than a few individuals per year.~~ 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. Because of these closures, the potential for mortality of coastal bottlenose dolphins in the California set gillnet fishery has been greatly reduced since 1994. Fisher self-report data and stranding records for 1994-98 do not include any records of fishery interactions for this stock. ~~Heyning et al. (1994) report that four bottlenose dolphins stranded with evidence of fishery interactions between 1975 and 1990, but the stock identity of these animals and the responsible fishery are not known. In 1994, California set gillnet fisheries were banned from nearshore areas where coastal bottlenose dolphins are found.~~ 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 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 19~~91-95~~**
CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery	observer data	1991-94 1995-98	10-15% 0%	0	~~none or few~~ 0	0
~~**Undetermined**~~	~~strandings~~	~~1975-90~~	~~4 bottlenose dolphins of unknown stock stranded with evidence of fishery interactions~~			
Minimum total annual takes 19~~91-95~~						0

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).

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Revised ~~08/01/97~~ 01/03/00

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). ~~Although o~~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.

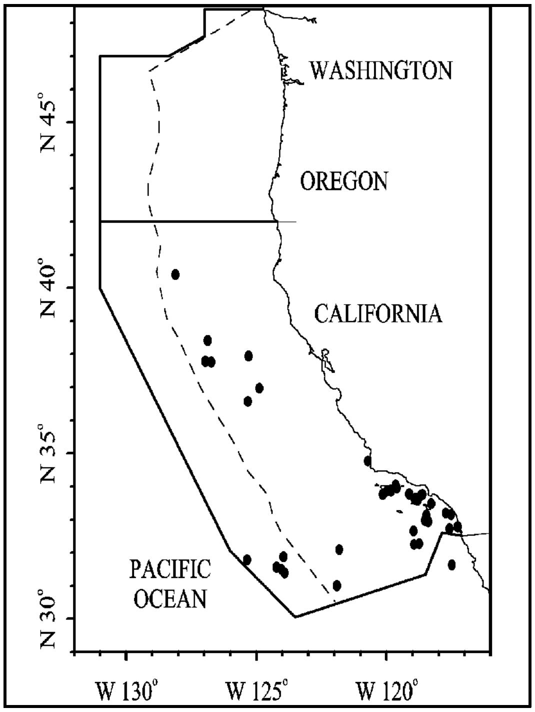

Figure 1. Offshore bottlenose dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-94~~ 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). All sightings were made at distances greater than a 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

~~Forney (1994) reviews recent abundance estimates for offshore bottlenose dolphins in Californian waters, and concludes that the best abundance estimate is a weighted average of estimates obtained from the 1991-92 aerial surveys (Forney et al. 1995) and the 1991 shipboard surveys (Barlow 1995). More recently, the results of an additional 1993 shipboard survey along the California coast have become available. Barlow and Gerrodette (1996) calculated a combined abundance estimate of 1,850 offshore bottlenose dolphins (CV = 0.50) based on the 1991 and 1993 shipboard surveys. Following the same weighted averaging procedure used previously by Forney (1994), the updated abundance estimate is 2,555 (CV = 0.36) offshore bottlenose dolphins.~~ 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 minimum population estimate for offshore bottlenose dolphins in California (defined as the log-normal 20th percentile of the above abundance estimate)~~ The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is ~~1,904 animals~~ 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

~~Based on this stock's unknown status and growth rate and given the precision of the estimate of annual fishery mortality (CV=1.00), the recovery factor (F_r) is 0.40. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 1,904 yields a potential biological removal (PBR) of 15 animals per year.~~ 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.

~~ANNUAL~~ 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. ~~In the California drift gillnet fishery, the observed average rate of kill for offshore bottlenose dolphins in the five most recent years of monitoring, 1991-95 is 3/3,125 = 0.0010 dolphins per fishing day, or one dolphin every 1,042 fishing days (Julian and Beeson, in press). The average estimated annual mortality for offshore bottlenose dolphins in this fishery for 1991-95 is 4.4 animals (CV=1.00).~~ 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.

~~Similar d~~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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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.).

~~Based on logbook data for 1990-92, one additional mortality of an offshore bottlenose dolphin was documented in the California anchovy, mackerel and tuna purse seine fishery. Thus the minimum mortality for this period is 0.33 animals per year; however, no estimate of total mortality can be made for this fisheries.~~

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.

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. ~~All observed entanglements of offshore bottlenose 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 ~~1991-95~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~1991~~	~~9.8%~~	~~0~~	~~0~~	
		~~1992~~	~~13.6%~~	~~3~~	~~22 (0.93)~~	~~4.4 (1.00)~~
		~~1993~~	~~13.4%~~	~~0~~	~~0~~	
		1994	17.9%	0	0	
		1995	15.6%	0	0	
		1996	12.4%	0	0	0[1]
		1997	23.0%	0	0	
		1998	20.0%	0	0	
~~**CA anchovy, mackerel and tuna purse seine fishery**~~	~~logbook data~~	~~1990-92~~		~~1~~	~~min. 0.33~~	~~n/a~~
~~**Undetermined**~~	~~strandings~~	~~1975-90~~	~~4 bottlenose dolphins of unknown stock stranded with evidence of fishery interactions~~			
Minimum total annual takes ~~1991-95~~						~~4.4 (1.00)~~ 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.

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 the average annual human-caused mortality in 1991-95 (4.4 animals) is estimated to be less than the PBR (15), they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock during 1991-95 is greater than 10% of the calculated PBR, and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.~~ 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.

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Revised ~~08/01/97~~ 01/03/00

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.

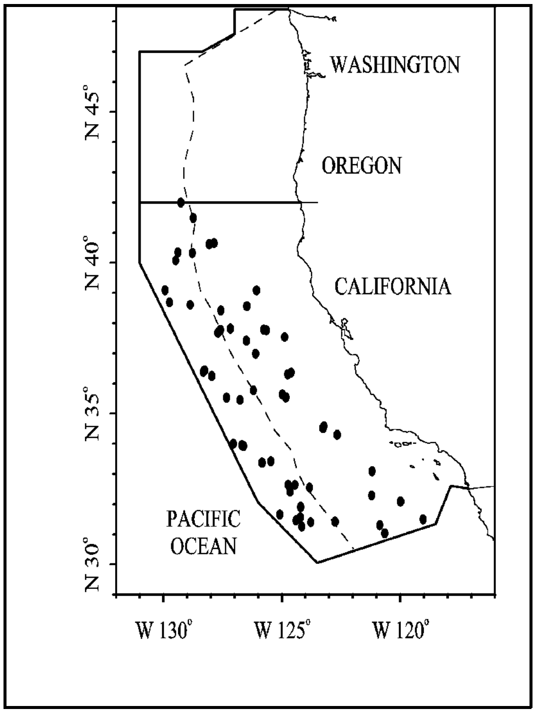

Figure 1. Striped dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-94~~ 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

~~In a recent analysis combining data from 1991 and 1993 shipboard surveys conducted within 300 nmi of the California coast, Barlow and Gerrodette (1996) estimate the abundance of striped dolphins to be 24,910 (CV = 0.31).~~ 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 minimum population estimate for striped dolphins in California (defined as the log-normal 20th percentile of the above abundance estimate)~~ The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is ~~19,248 animals~~ 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

~~Based on this stock's unknown status and growth rate and given the precision of the estimate of annual fishery mortality (CV=1.00), the recovery factor (F_r) is 0.4, and ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 19,248 yields a potential biological removal (PBR) of 154 animals per year.~~

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.

~~ANNUAL~~ 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. ~~In the California drift gillnet fishery, the observed average rate of kill for striped dolphins for the five most recent years of monitoring, 1991-95 is 1/3,125 = 0.0003 dolphins per fishing day, or one dolphin every 3,125 fishing days (Julian and Beeson, in press). The average estimated annual mortality for striped dolphins in this fishery for 1991-95 is 1.2 (CV=1.00) animals.~~ 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 ~~1991-95~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~1991~~	~~9.8%~~	~~0~~	~~0~~	~~1.2 (1.00)~~
		~~1992~~	~~13.6%~~	~~0~~	~~0~~	
		~~1993~~	~~13.4%~~	~~0~~	~~0~~	
		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 ~~1991-95~~						~~1.2 (1.00)~~ 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.

~~Similar d~~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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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. ~~Because the average annual human-caused mortality in 1991-95 (1.2 animals) is estimated to be less than the PBR (154), they are not classified as a "strategic" stock as defined by the MMPA. The total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero, because the average annual human-caused mortality in 1991-95 is estimated to be less than 10% of the total PBR.~~ 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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

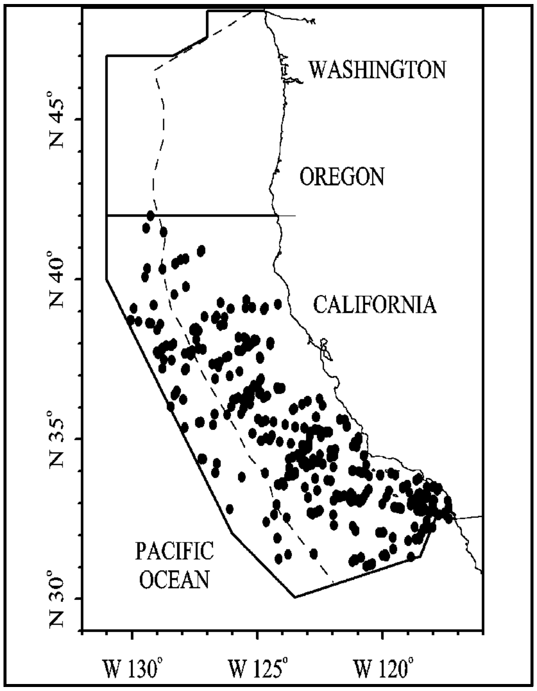

Figure 1. Short-beaked common dolphin sightings based on ~~1991 and 1993 California~~ shipboard surveys~~, during which the two species of *Delphinus* were differentiated~~ off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 3-5, for data sources and information on timing and location 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.

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 42ºN (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). ~~Winter/spring surveys in 1991-92 did not result in any sightings of common dolphins north of Point Conception (Carretta and Forney 1993), suggesting seasonal north-south movements of this species.~~ Their distribution is continuous southward into Mexican waters to about 13ºN (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.

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~~, based on 1991 and 1993 shipboard surveys within 300 nmi of the California coast, during which the two species of common dolphin could be distinguished, is 8,980 (CV=0.64) long-beaked common dolphins (Barlow and Gerrodette 1996).~~ 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 ~~from the combined 1991 and 1993 shipboard surveys~~ is ~~309,717~~ 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 ~~A~~ recent ~~analysis including data from a 1993 summer survey resulted in a further increase in the abundance estimate (Barlow and Gerrodette 1996)~~. 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 ~~combined~~ 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

~~Based on this stock's unknown status, the recovery factor (F_r) is 0.5. Multiplying this times the default annual growth rate (½ R_{max}) of 0.02 and the minimum abundance estimate of 309,717 yields a potential biological removal (PBR) of 3,097 short-beaked common dolphins per year.~~ 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.

~~ANNUAL~~ 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 ~~the majority of~~ all except two of the common dolphins killed (NMFS, unpublished data). ~~Between January 1991 and December 1995, 161 short-beaked common dolphins were documented to have been killed in driftnets (Julian and Beeson, in press). An additional 18 common dolphins (including one animal released alive) have not been positively identified to species at this time, but based on previous patterns, the majority of these are likely to have been short-beaked common dolphins. Using the proportion of identified common dolphins that were determined to be short-beaked common dolphins (161/170 = 0.947) to prorate the remaining 18 unidentified~~

~~specimens, the total observed short-beaked common dolphin mortality for the period January 1991 - December 1995 would be 161+16 = 177 animals, plus one common dolphin that was released alive. The observed average rate of kill for short-beaked common dolphins in 1991-95 (including prorated animals) is 177/3,125 = 0.0566 dolphins per fishing day, or one dolphin every 18 fishing days (Julian and Beeson, in press). Estimates of total annual mortality for short-beaked common dolphins, using this same method to prorate the unidentified common dolphins based on data provided in Julian and Beeson (in press), are shown in Table 1~~ 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. ~~The average estimated annual mortality and injury for short-beaked common dolphins for the five most recent years of monitoring, 1991-95, is 272 (CV=0.19) animals.~~ 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), ~~and prorated unidentified common dolphins~~ in commercial fisheries that might take this species. ~~Only one unidentified common dolphin was released alive in the driftnet fishery in 1992; all other~~ All entanglements resulted in the death of the animal. ~~In the setnet fishery, the two common dolphins killed in 1992 were not identified to the species level and could have been short-beaked or long-beaked common dolphins.~~ The observer program for the set gillnet fishery was discontinued during 1994~~, so total 1995 mortality was estimated using mortality rates for the most recent complete year of monitoring (1993) and total fishing effort for 1995 (Julian and Beeson, in press)~~. Coefficients of variation for mortality estimates are provided in parentheses~~, when~~; 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 ~~+ Prorated~~ Mortality	Estimated Annual Mortality~~, observed + prorated~~	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~1991~~ ~~1992*~~ ~~1993~~ 1994 1995 1996 1997 1998	~~9.8%~~ ~~13.6%~~ ~~13.4%~~ 17.9% 15.6% 12.4% 23.0% 20.0%	~~37 + 6~~ ~~39 + 5~~ ~~24 + 4~~ ~~25 + 1~~ 26 36 ~~+ 0~~ 27 21 9	~~376 (0.21) + 61~~ ~~287 (0.21) + 37~~ ~~179 (0.26) + 30~~ 146 ~~140~~ (0.18)~~ + 6~~ 231 (0.29) ~~+ 0~~ 319 (0.23) 105 (0.30) 51 (0.33)	~~271 (0.19)~~ (includes prorated ~~and released alive~~) 78 (0.23)[1]
		~~*1992, if animal released alive is included~~		~~39 + 6~~	~~287 (0.21) + 44~~	
CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery		Common dolphins, species not determined				
	observer data	~~1991~~ ~~1992~~ ~~1993~~ 1994 1995-98	~~9.8%~~ ~~12.5%~~ ~~15.4%~~ 7.7% 0%	~~0~~ ~~2~~ ~~0~~ 0 n/a	~~0~~ ~~15 (0.66)~~ ~~0~~ 0 n/a	~~> 1[1]~~ n/a
	MMAP self-reporting	1995 1996 1998	- - -	1 1 2	>1 >1 ≥2	≥0.8 (n/a)
Undetermined	strandings	1994-98	2 common dolphins (species not determined) stranded with evidence of fishery interactions			≥0.4 (n/a)
Minimum total annual takes						~~272 (0.19)~~ 79 (0.23)

[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 common dolphin mortality has been reported for set gillnets in California (~~Table 1~~Julian and Beeson 1998); however, because of a 1994 ban on gillnets in nearshore areas of Southern California, ~~the size of this fishery has been dramatically reduced in recent years~~ the size of this fishery decreased by about a factor of two (see Appendix 1), and the observer program was discontinued. ~~Using only the two most recent years since implementation of the ban and permanent area closures, the average estimated annual mortality for common dolphins (type not specified) in this fishery in 1994-1995 is zero animals (Julian and Beeson, in press).~~ 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.

~~Similar d~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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 ~~1991~~ 1994 and ~~1995~~ 1998, annual mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between 9 and ~~1,773~~ 261 animals, with an average of ~~426~~ 91 (IATTC, in prep) ~~Hall and Lennert 1993, 1994, 1995, 1996; Lennert and Hall 1994~~). 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. ~~The average estimated annual human-caused mortality and injury for this species in 1991-95 (272 animals) is lower than the PBR (3,097), so they are not a "strategic" stock 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.

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Revised ~~08/01/97~~ 01/03/00

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.

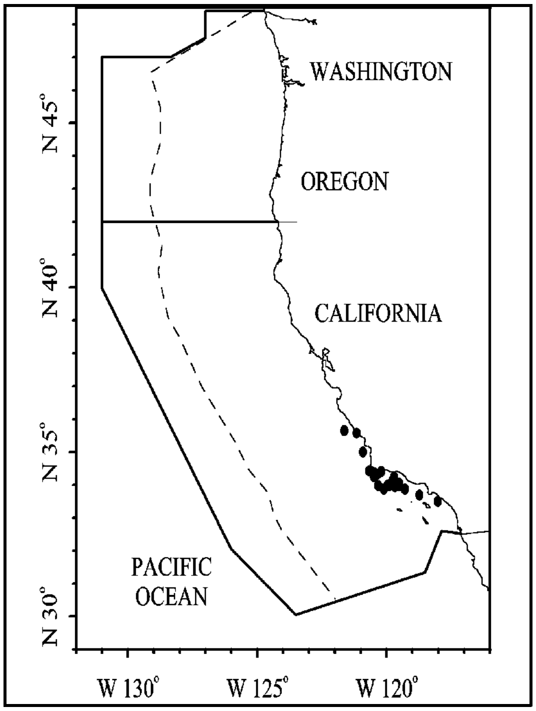

Figure 1. Long-beaked common dolphin sightings based on ~~1991 and 1993 California~~ shipboard surveys~~, during which the two species of *Delphinus* were differentiated~~ off California, Oregon and Washington, 1991-96 (see Appendix 2, Figures 3-5, for data sources and information on timing and location 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~~, based on 1991 and 1993 shipboard surveys within 300 nmi of the California coast, during which the two species of common dolphin could be distinguished, is 8,980 (CV=0.64) long-beaked common dolphins (Barlow and Gerrodette 1996).~~ 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 ~~from the combined 1991 and 1993 shipboard surveys~~ is ~~5,504~~ 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 ~~combined~~ 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

~~Based on this stock's unknown status and given the precision of the estimate of annual fishery mortality (CV=0.48), the recovery factor (F_r) is 0.48. Multiplying this times the default annual growth rate (½ R_{max}) of 0.02 and the minimum abundance estimate of 5,504 yields a potential biological removal (PBR) of 53 long-beaked common dolphins per year.~~ 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 ≤ 0.80; Wade and Angliss 1997), resulting in a PBR of 250 long-beaked common dolphins per year.

~~ANNUAL~~ 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 ~~the majority of~~ all except two of the common dolphins killed (NMFS, unpublished data). ~~Between January 1991 and December 1995, nine long-beaked common dolphins were documented to have been killed in driftnets (Julian and Beeson, in press). An additional 18 common dolphins (including one animal released alive) have not been positively identified to species at this time, but based on previous patterns, the majority of these are likely to have been short-beaked common dolphins. Using the proportion of identified common dolphins that were determined to be long-beaked common dolphins (9/170 = 0.053) to prorate the remaining 18 unidentified specimens, the total observed long-beaked common dolphin mortality for the period January 1991 - December 1995 would be 9+1 = 10 animals. The observed average rate of kill for long-beaked common dolphins in 1991-95 (including prorated animals) is 10/3,125 = 0.0032 dolphins per fishing day, or one dolphin every 313 fishing days (Julian and Beeson, in press). Estimates of total annual mortality for long-beaked common dolphins, using this same method to prorate the unidentified common dolphins based on data provided in Julian and Beeson (in press), are shown in Table 1.~~ 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. ~~The average estimated annual mortality for long-beaked common dolphins for the five most recent years of monitoring, 1991-95, is 14 (CV=0.48) animals.~~ 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 (~~Table 1~~Julian and Beeson 1998); however, because of a 1994 ban on gillnets in nearshore areas of Southern California, ~~the size of this fishery has been dramatically reduced in recent years~~ the size of this fishery decreased by about a factor of two (see Appendix 1), and the observer program was discontinued. ~~Using only the two most recent years since implementation of the ban and permanent area closures, the average estimated annual mortality for common dolphins (type not specified) in this fishery in 1994-1995 is zero animals (Julian and Beeson, in press).~~ 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. ~~In the setnet fishery, the two common dolphins killed in 1992 were not identified to the species level and could have been short-beaked or long-beaked common dolphins.~~ The observer program for the set gillnet fishery was discontinued during 1994~~, so total 1995 mortality was estimated using mortality rates for the most recent complete year of monitoring (1993) and total fishing effort for 1995 (Julian and Beeson, in press)~~. 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 ~~+ Prorated Mortality~~	Estimated Annual Mortality~~, observed + prorated~~	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~1991~~	~~9.8%~~	~~0 + 1~~	~~0 + 10~~	~~14 (0.48)~~
		~~1992~~	~~13.6%~~	~~2 + 0~~	~~15 (0.92) + 0~~	
		~~1993~~	~~13.4%~~	~~0 + 0~~	~~0 + 0~~	
		1994	17.9%	1~~ + 0~~	6 (0.91)~~ + 0~~	
		1995	15.6%	6~~ + 0~~	39 (0.65)~~ + 0~~	
		1996	12.4%	1	12 (0.96)	13 (0.74)[1]
		1997	23.0%	4	25 (0.74)	
		1998	20.0%	0	0	
CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery		Common dolphins, species not determined				
	observer data	~~1991~~	~~9.8%~~	~~0~~	~~0~~	
		~~1992~~	~~12.5%~~	~~2~~	~~15 (0.66)~~	
		~~1993~~	~~15.4%~~	~~0~~	~~0~~	~~> 1~~ n/a
		1994	7.7%	0	0	
		1995-98	0%	n/a	n/a	
	MMAP self-reporting	1995	-	1	>1	≥0.8 (n/a)
		1996	-	1	>1	
		1998	-	2	≥2	
Undetermined	strandings	1994-98	2 common dolphins (species not determined) stranded with evidence of fishery interactions			≥0.4 (n/a)
Minimum total annual takes						~~14 (0.48)~~ 14 (0.74)

~~[1] Only the two most recent years are used to calculate mean annual takes, because the size of the set gillnet fishery was reduced dramatically after a 1994 ban on gillnets in nearshore waters of Southern California (see Appendix 1).~~

[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.

~~Similar d~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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 ~~1991~~ 1994 and ~~1995~~ 1998, annual mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between 9 and ~~1,773~~ 261 animals, with an average of ~~426~~ 91 (IATTC, in prep) ~~Hall and Lennert 1993, 1994, 1995, 1996; Lennert and Hall 1994~~). 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. ~~Because the average annual human-caused mortality for this species (14 animals) is estimated to be lower than the PBR (53), they are not classified as a "strategic" stock 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 ~~greater~~ less than 10% of the PBR and, therefore, can~~not~~ be considered to be insignificant and approaching zero mortality and serious injury rate.

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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.~~, in press~~ 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.

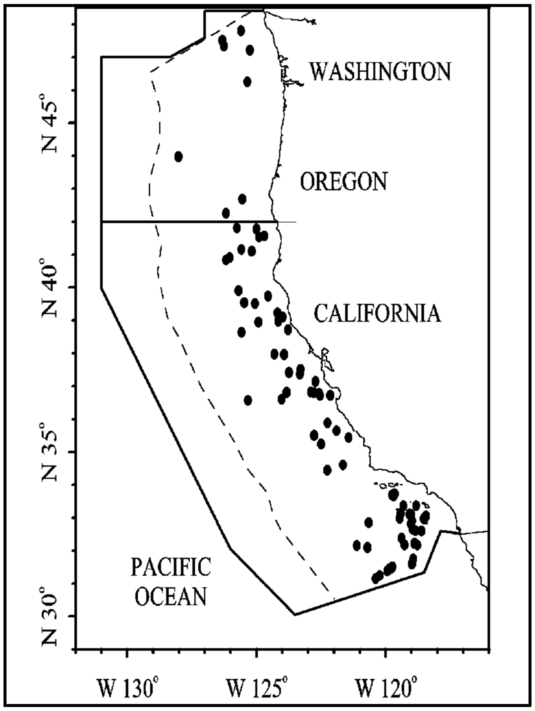

Figure 1. Northern right whale dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-94~~ 1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

~~Forney (1994) reviews recent abundance estimates for northern right whale dolphins along the U.S. west coast and concludes that the best estimate of overall population size in California, Oregon and Washington is the estimate obtained from aerial surveys conducted off California during winter and spring of 1991 and 1992 (Forney et al. 1995). Because of the observed seasonal shifts in distribution, this estimate of 21,332 animals (CV=0.43) is expected to include animals which may be found off Oregon and Washington in the summer/fall. After analysis of data collected during a comprehensive shipboard survey along the entire coast of California, Oregon and Washington in the summer of 1996 (NMFS, Southwest Fisheries Science Center), a summer abundance estimate for the entire defined stock range will be available.~~ 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 ~~above~~ 1991-96 weighted average abundance estimate is ~~15,080~~ 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

~~Based on this stock's unknown status and growth rate, the recovery factor (F_r) is 0.5, and ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 15,080 yields a potential biological removal (PBR) of 151 northern right whale dolphins per year.~~ 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.

~~ANNUAL~~ 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. ~~In the California drift gillnet fishery, the observed average rate of kill for northern right whale dolphins in 1991-95 is 32/3,125 = 0.0102 dolphins per fishing day, or one dolphin every 98 fishing days (Julian and Beeson, in press). The average estimated annual mortality for northern right whale dolphins in this fishery for the five most recent years of monitoring, 1991-95, is 47 (CV=0.20) animals.~~ 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	~~1991~~	~~9.8%~~	~~7~~	~~71 (0.41)~~	~~47 (0.20)~~
		~~1992~~	~~13.6%~~	~~2~~	~~15 (0.65)~~	
		~~1993~~	~~13.4%~~	~~7~~	~~52 (0.39)~~	
		1994	17.9%	7	39 (0.42)	15 (0.42)[1]
		1995	15.6%	9	58 (0.59)	
		1996	12.4%	5	27 (0.68)	
		1997	23.0%	5	29 (0.42)	
		1998	20.0%	0	0	
Minimum total annual takes						~~47 (0.20)~~ 15 (0.42)

[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.

~~Similar d~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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.).

~~An experimental gillnet fishery for thresher shark off Oregon and Washington in 1986-89 also reported mortality of northern right whale dolphins; however, this fishery was discontinued after 1989 due to the high rates of marine mammal and turtle bycatch (Stick and Hreha, 1989).~~

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. ~~The average annual human-caused mortality for 1991-95 (47 animals) is estimated to be less than the PBR (151), and therefore they are not classified as a "strategic" stock 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.

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KILLER WHALE (*Orcinus orca*):
Eastern North Pacific Transient 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).

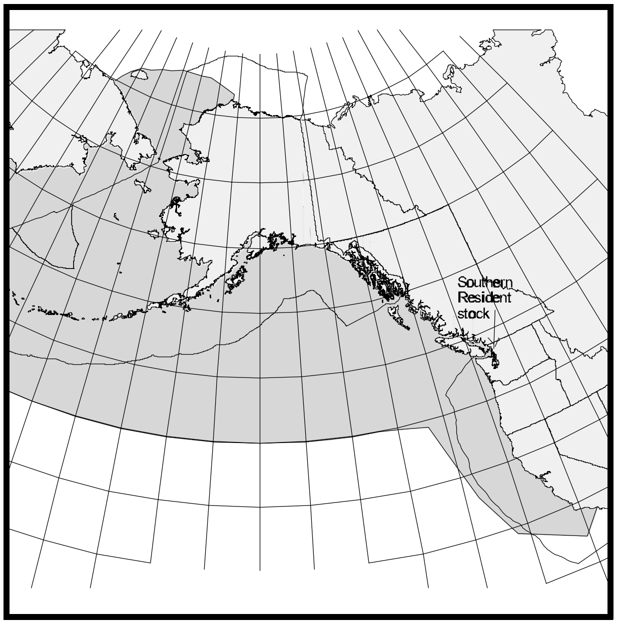

Figure 1. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the Eastern North Pacific Northern Resident and Transient stocks are largely overlapping (see text).

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).

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 (see Fig. 1), 4) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California, and 5) the Hawaiian stock. 'Transient' whales in Canadian waters are considered part of the Eastern North Pacific Transient 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 Northern Transient stock is a trans-boundary stock, including killer whales from British Columbia. Preliminary analysis of photographic data resulted in the following minimum counts for 'transient' killer whales belonging to the Eastern North Pacific Transient stock (Note: individual whales have been matched between geographical regions and missing animals likely to be dead have been subtracted). In British Columbia and southeastern Alaska, 219 ~~213~~ ‘transient’ whales have been cataloged (Ford and Ellis 1999), and preliminary analyses indicate there are an additional 14 ‘transient’ whales, classified by association, in southeastern Alaska (Dahlheim, unpubl. data). In the Gulf of Alaska, 21 ~~17~~ ‘transient’ killer whales have been identified genetically and/or acoustically (Matkin et al. 1999 ~~L. Barrett-Lennard, pers. comm.~~). The ‘transient’ group AT1, commonly seen in Prince William Sound/Kenai Fjords, ~~was thought to have~~ had only 11 remaining whales ~~alive~~ in 1998 ~~1997~~ (Matkin et al. 1999 ~~1998~~). Based on data collected from all Alaska waters west of Seward (Dahlheim and Waite 1993; Dahlheim 1994, 1997), 68 whales are considered ‘residents’ as they have been linked by association to ‘resident’ whales from Prince William Sound (G. Ellis, pers. comm.), and the remainder are provisionally classified as 174 ‘residents’ and 53 ‘transients.’ Provisional classifications were based primarily on morphological differences identified from the photographs. Accordingly, the numbers of ‘residents’ and ‘transients’ in Alaska waters west of Seward are considered preliminary at this time. Off the coast of California, ~~Black et al. (1997) identified~~ 121 ~~105~~ ‘transient’ whales have been identified (Black et al. 1997; N. Black, pers. comm.): 10 whales were matched to photos of ‘transients’ in other catalogs and the remaining 111 ~~95~~ were linked by association. Combining the counts of ‘transient’ whales gives a minimum number of 376 ~~336~~ (219 ~~213~~ + 14 + 21 ~~17~~ + 11 + 111 ~~95~~) killer whales belonging to the Eastern North Pacific Transient stock.

Minimum Population Estimate

The survey technique used ~~utilized~~ for obtaining the abundance estimate of killer whales is a direct count of individually identifiable animals. Given that researchers continue to identify new whales, the estimate of abundance based on the number of uniquely identified individuals known to be alive is likely conservative. However, the rate of discovering new whales within Southeast Alaska and Prince William Sound is relatively low. In addition, the abundance estimate does not include 53 unclassified whales from western Alaska that have been provisionally classified as ‘transients’.

Other estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) are not currently available. Thus, the minimum population estimate (N_{MIN}) for the Eastern North Pacific Transient stock of killer whales is 376 ~~336~~ animals, which includes animals found in Canadian waters (see PBR Guidelines regarding the status of migratory trans-boundary stocks, Wade and Angliss 1997). Information on the percentage of time animals typically encountered in Canadian waters spend in U.S. waters is unknown. However, as noted above, this minimum population estimate is considered conservative. This approach is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1996).

Current Population Trend

At present, reliable data on trends in population abundance for the Eastern North Pacific Transient stock of killer whales are unavailable.

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 the Pacific Northwest 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 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

Under the 1994 re-authorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.45, the value for cetacean stocks with unknown population status and a mortality estimate CV between 0.6 and 0.8 (Wade and Angliss 1997). Thus, for the Eastern North Pacific Transient killer whale stock, PBR = 3.4 ~~3.0~~ animals (376 ~~336~~

× 0.02 × 0.45). The proportion of time that this trans-boundary stock spends in Canadian waters cannot be determined (G. Ellis, pers. comm.).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Six different commercial fisheries in Alaska that could have interacted with killer whales were monitored for incidental take by fishery observers from ~~1993~~ 1994 to 1998 ~~1997~~: Bering Sea/ ~~(and~~ Aleutian Islands~~)~~ (BSAI) and Gulf of Alaska groundfish trawl, longline, and pot fisheries. Of the six observed fisheries, killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Table 1; Perez in prep.; M. Perez, unpubl. data). ~~For the fisheries with observed takes, the range of observer coverage over the 5-year period, as well as the annual observed and estimated mortalities, are presented in Table 1~~). From 1994 to 1998, one killer whale mortality was observed in 1997 in the Bering Sea groundfish trawl fishery. The 1995 mortality in the longline fishery occurred during an unmonitored haul and could not be used to estimate total mortality for the fishery ~~(28% observer coverage in 1995)~~. ~~For computational purposes, the estimated mortality in 1995 was set at 1, because at a minimum, one whale is known to have perished in that year. The 1993 mortality in the trawl fishery occurred under similar circumstances and was treated in the same manner (66% observer coverage in 1993).~~

NMFS observers also monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from ~~1993~~ 1994 to 1998 ~~1997~~ (Table 1; Julian 1997, ~~Cameron 1998,~~ Julian and Beeson 1998, Cameron and Forney 1999). The observed mortality in this fishery, in 1995, was a transient whale as determined by genetic testing (S. Chivers, pers. comm.). Additional fisheries that could interact with the Eastern North Pacific Transient stock of killer whales are listed in Appendix 1 ~~of Barlow et al. (1997)~~.

The mean annual mortality was 0.4 ~~0.6~~ (CV=1.0 ~~0.67~~) for the Bering Sea groundfish trawl fishery, 0.2 (0 from monitored hauls + 0.2 from unmonitored haul data) ~~(CV=1.0)~~ for the combined Bering Sea longline fishery, and 1.2 (CV=1.0) for the California/Oregon thresher shark/swordfish drift gillnet fishery, resulting in a mean annual mortality rate of 1.8 ~~2.0 (CV= 0.64)~~ killer whales per year from observed fisheries.

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 ~~1990~~ 1994 and 1998 ~~1997~~, there were no fisher self-reports of killer whale mortalities from any ~~all~~ Alaska fisheries operating within the range of this stock ~~indicated only one killer whale mortality, which occurred in the Bering Sea groundfish trawl fishery in 1990~~. 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). ~~Thus, the observer program provides more reliable estimates of mortality than the fisher self-reports.~~

The estimated minimum mortality rate incidental to recently monitored U.S. commercial fisheries ~~recently monitored~~ is 1.8 ~~2.0~~ animals per year, based ~~exclusively~~ on observer data (1.6 from monitored hauls + 0.2 from unmonitored hauls). As the animals which were taken incidental to commercial fisheries in Alaska have not been identified genetically, it is not possible to determine whether they belonged to the Eastern North Pacific Northern Resident or the Eastern North Pacific Transient killer whale stock. Accordingly, these same mortalities can be found in the stock assessment report for the Northern Resident stock.

Table 1. Summary of incidental mortality of killer whales (Eastern North Pacific Northern Transient stock) due to commercial fisheries from ~~1993~~ 1994 through 1998 ~~1997~~ and calculation of the mean annual mortality rate. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery name	Years	Data type	Percent ~~Range of~~ observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean Annual Takes (CV in parentheses)
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	~~93-97~~	obs data	~~64-67%~~	~~1,~~	~~1,~~	0.4 ~~0.6~~
	94		65.5%	0	0	(~~0.67~~ 1.0)
	95		67.3%	0	0	
	96		66.2%	0	0	
	97		63.9%	1	2	
	98		67.0%	0	0	
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries)	~~93-97~~	obs data	~~27-33%~~	~~0,~~	~~0,~~	~~0.2~~
	94		27.3%	0	0	~~(CV=1.0)~~
	95		28.0%	~~1~~ 0	~~1~~ 0	0
	96		28.7%	0	0	
	97		32.5%	0	0	
	98		36.2%	0	0	
	95	unmonitored haul		1		0.2
CA/OR thresher shark/ swordfish drift gillnet	~~93-97~~	obs data	~~12-27%~~	~~0,~~	~~0,~~	~~1.2~~
	94		17.9%	0	0	~~(CV=1.0)~~
	95		15.6%	1	6	0[1]
	96		12.4%	0	0	
	97		23.0%	0	0	
	98		20.0%	0	0	
Observer program totals						
monitored hauls						1.6 (CV=0.79)
unmonitored hauls						0.2
Estimated total annual mortality						~~2.0~~ ~~(CV=0.64)~~ 2.4 (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.

Due to a lack of Canadian observer programs, there are few data concerning the mortality of marine mammals incidental to Canadian commercial fisheries, which are analogous to U.S. fisheries that are known to interact with killer whales. The sablefish longline fishery accounts for a large proportion of the commercial fishing/killer whale interactions in Alaska waters. Such interactions have not been reported in Canadian waters where sablefish are taken via a pot fishery. 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 it did not entangle (Guenther et al. 1995). Data regarding the level of killer whale mortality related to commercial fisheries in Canadian waters, though thought to be small, are not readily available or reliable which results in an underestimate of the annual mortality for this stock.

Subsistence/Native Harvest Information

There are no reports of a subsistence harvest of killer whales in Alaska or Canada.

Other Mortality

There is considerable interaction between killer whales and longline vessels in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez in prep.; M. Perez, unpubl. data), as well as reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (M. Perez, unpubl. data). However, it most likely is the 'resident' stock of killer whales that is involved in such fishery interactions since these whales are known to be fish eaters, while 'transient' whales have only been observed feeding on marine mammals. ~~Since 1986, research efforts have been made to assess the nature and magnitude of killer whale/blackcod (sablefish; *Anoplopoma fimbria*) fishery interactions (Yano and Dahlheim 1995, Dahlheim 1988). Fishery interactions have occurred each year in the Bering~~

~~Sea and Prince William Sound, with the number of annual reports varying considerably. Data collected from the Japan/U.S. cooperative longline research surveys operating in the Bering Sea indicate that interactions may be increasing and expanding into the Aleutian Island region (Yano and Dahlheim 1995). During the 1992 surveys conducted in the Bering Sea and western Gulf of Alaska, 9 of 182 (4.9%) individual whales in 7 of the 12 (58%) pods encountered had evidence of bullet wounds (Dahlheim and Waite 1993). The relationship between wounding due to shooting and survival is unknown. In Prince William Sound, the pod responsible for most of the fishery interactions has experienced a high level of mortality: between 1986 and 1991, 22 whales out of a pod of 37 (59%) are missing and considered dead (Matkin et al. 1994). The cause of death for these whales is unknown, but may be related to gunshot wounds or effects of the *Exxon Valdez* oil spill (Dahlheim and Matkin 1994).~~

The shooting of killer whales in Canadian waters has also been a concern in the past. However, in recent years there have been no reports of shooting incidents in Canadian waters. In fact, the likelihood of shooting incidents involving ‘transient’ killer whales is thought to be minimal since commercial fishermen are most likely to observe ‘transients’ feeding on seals or sea lions instead of interacting with their fishing gear (G. Ellis, pers. comm.).

Collisions with boats are another source of mortality. One mortality due to a ship strike occurred in 1998, when a killer whale struck the propeller of a vessel in the Bering Sea groundfish trawl fishery, resulting in an estimated annual mortality of 0.2 killer whales from this stock in 1994-1998.

~~Other Issues~~

~~Although only small numbers of killer whales are taken in the Bering Sea fisheries, there is considerable interaction between the whales and the fisheries. Interactions between killer whales and longline vessels have been well documented (Dahlheim 1988, Yano and Dahlheim 1995). In 1997, the first year that predation data were collected in the Bering Sea and Gulf of Alaska groundfish trawl, longline and pot fisheries, NMFS observers recorded killer whale predation and/or deterrence events during 187 longline sets: 179 in the Bering Sea and 8 in the Gulf of Alaska. A total of 183 whales were deterred (through the use of seal bombs or acoustic alarms suspended from the vessels) from 20 sets in the Bering Sea and one group of 35 whales was deterred from a set in the Gulf of Alaska. Less has been documented regarding interactions with the trawl fishery, but several observers reported that large groups of killer whales in the Bering Sea followed vessels for days at a time, actively consuming the processing waste (Fishery Observer Program, unpubl. data). However, it may be the ‘resident’ stock of killer whales that is involved in such fisheries interactions since these whales are known to be fish eaters, while ‘transient’ whales have only been observed feeding on marine mammals.~~

STATUS OF STOCK

Killer whales are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. Recall, that the human-caused mortality has been underestimated primarily due to a lack of information on Canadian fisheries, and that the minimum abundance estimate is considered conservative (because researchers continue to encounter new whales and unclassified whales from western Alaska were not included), resulting in a conservative PBR estimate. Based on currently available data, the estimated annual fishery-related mortality level (1.8 ~~2.0~~) exceeds 10% of the PBR (0.34 ~~0.30~~) and, therefore, can not be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (1.8+0.2=2.0 animals per year) is not known to exceed the PBR (3.4 ~~3.0~~). Therefore, the Eastern North Pacific Transient stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

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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).

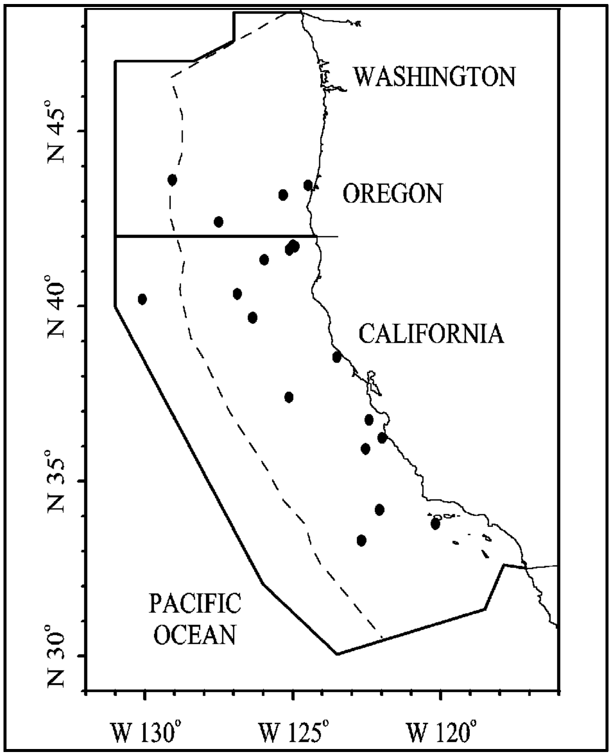

Figure 1. Killer whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1989-96~~1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Sightings include killer whales from all stocks found in this region. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. ~~Greater effort was conducted off California (south of 42°N) and in the inshore half of the U.S. EEZ. See Appendix 2 of Barlow et al. (1997) and Barlow (1997) for data sources and information on timing and location of survey effort.~~

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 can be found in Barlow et al. (1997).

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

~~Based on this stock's unknown status and growth rate and the lack of observed fishery mortality, the recovery factor (F_r) is 0.5. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 209 yields a potential biological removal (PBR) of 2.1 animals per year.~~ 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 ~~recent~~ information on fisheries that may take animals from ~~fishery mortality and injury for~~ this killer whale stock is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. ~~of Barlow et al. (1997)~~. In the California drift gillnet fishery, no offshore killer whales have been observed entangled (~~Cameron 1998~~ 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 ~~observation~~ 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	~~1993~~	~~13.4%~~	~~0~~	~~0~~	0[1]
		1994	17.9%	0	0	
		1995	15.6%	0	0	
		1996	12.4%	0	0	
		1997	~~26.6~~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.

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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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.

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Revised ~~09/30/99~~ 01/03/00

KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

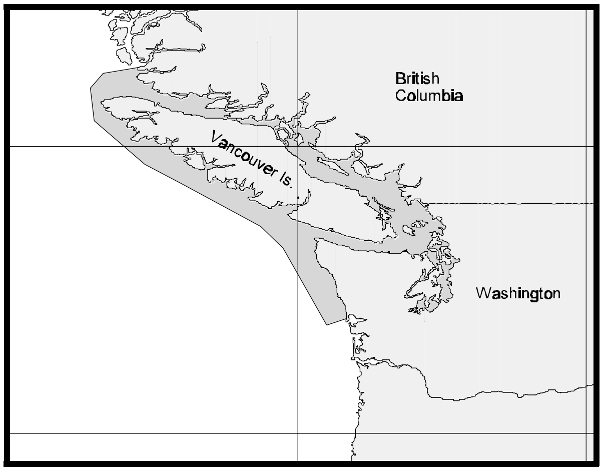

Figure 1. Approximate distribution of the Eastern North Pacific Southern Resident killer whale stock, April through October (shaded area).

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).

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). Although some pods belonging to the Eastern North Pacific Southern Resident stock have been sighted off the outer Washington coast as far south as Grays Harbor (Bigg et al. 1990), most killer whale sightings in Washington have occurred in the inland waters.

Based on data regarding association patterns, acoustics, movements, genetic differences and potential fishery interactions, five killer whales 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 (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). Counts remained in the mid-high 90s until 1995, then

~~a recent~~ decreased steadily to the current population of 84 ~~to 89~~ whales (Fig. 2; Center for Whale Research, unpubl. data).

Minimum Population Estimate

The survey technique utilized for obtaining the abundance estimate for this stock of killer whales is a direct count of individually identifiable animals. Other estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) are not currently available. Thus, the minimum population estimate (N_{MIN}) for the Eastern North Pacific Southern Resident stock of killer whales is 84 ~~89~~ 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 an annual growth rate of 1.8% during those years. The population peaked at 99 whales in 1995, then decreased to 84 ~~89~~ whales from 1995 to 1999 ~~1998~~ (Center for Whale Research, unpubl. data).

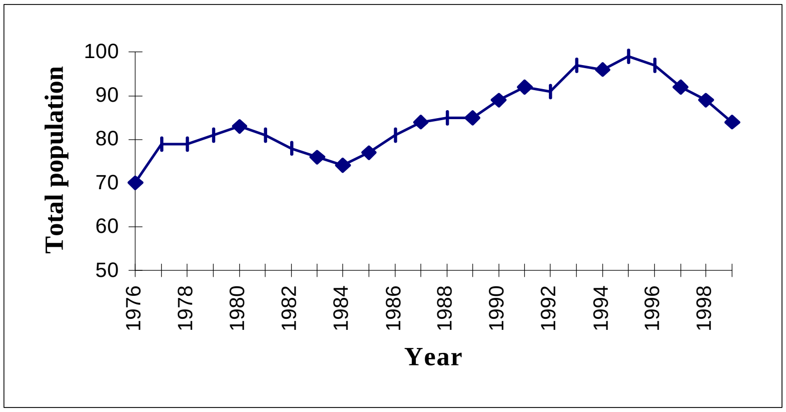

Figure 2. Population of Eastern North Pacific Southern Resident stock of killer whales, 1976-1999 ~~1998~~. Each year's count includes animals first seen and first missed; a whale is considered first missed the year after it was last seen alive (Center for Whale Research, unpubl. data).

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

Under the 1994 re-authorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks of unknown status (Wade and Angliss 1997). Thus, for the Eastern North Pacific Southern Resident killer whale stock, PBR = 0.8 ~~0.9~~ animals (84 ~~89~~ × 0.02 × 0.5).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

NMFS observers have monitored the northern Washington marine set gillnet fishery since 1988. No killer whale mortalities have been recorded in this fishery since the inception of the observer program. Observer coverage ~~has~~ ranged from approximately ~~59~~ 40 to 98% in the~~is~~ entire fishery (coastal + inland waters) between ~~1992~~ 1993 and 1998 ~~1997~~, excluding 1994 in which no observer program occurred (Gearin et al. 1994, 1999; P. Gearin, unpubl. data).

In 1993, as a pilot for future observer programs, NMFS in conjunction with the Washington Department of Fish and Wildlife (WDF&W) 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 meters of a net) with killer whales were reported, but not quantified, though no entanglements occurred.

In 1994, NMFS and WDF&W 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, WDF&W, 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 meters 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 ~~1990~~ 1994 and 1998 ~~1997~~, 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 ~~from 1992 through 1997~~ and calculation of the mean annual mortality rate. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery name	**Years**	**Data type**	**Percent ~~Range of~~ observer coverage**	**Observed mortality (in given yrs.)**	**Estimated mortality (in given yrs.)**	**~~1993-97~~ Mean annual takes (CV in parentheses)**
Northern WA marine set gillnet (tribal fishery: coastal + inland waters)	~~92-97~~ 93 94 95 96 97 98	obs data	~~59-98%~~ 61% 0% 87% 59% 98% 40%	~~0,~~ 0 n/a 0 0 0 0	~~0,~~ 0 n/a 0 0 0 0	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%	0	0	0
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 (areas12,12B, and 12C)	94	obs data	2.2%	0	0	0

Fishery name	**Years**	**Data type**	**Percent ~~Range of~~ observer coverage**	**Observed mortality (in given yrs.)**	**Estimated mortality (in given yrs.)**	**~~1993-97~~ Mean annual takes (CV in parentheses)**
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 gill net (areas 7 and 7A)	94	obs data	7%	0	0	0
Observer program total						0
Minimum total annual mortality						0

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 ~~0.09~~) 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 ~~0.9~~). 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.

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Revised ~~09/30/99~~ 01/03/00

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; ~~Hill and~~ Barlow 199~~2~~7; 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; ~~Mangels~~ Barlow and Gerrodette 199~~4~~6), 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.

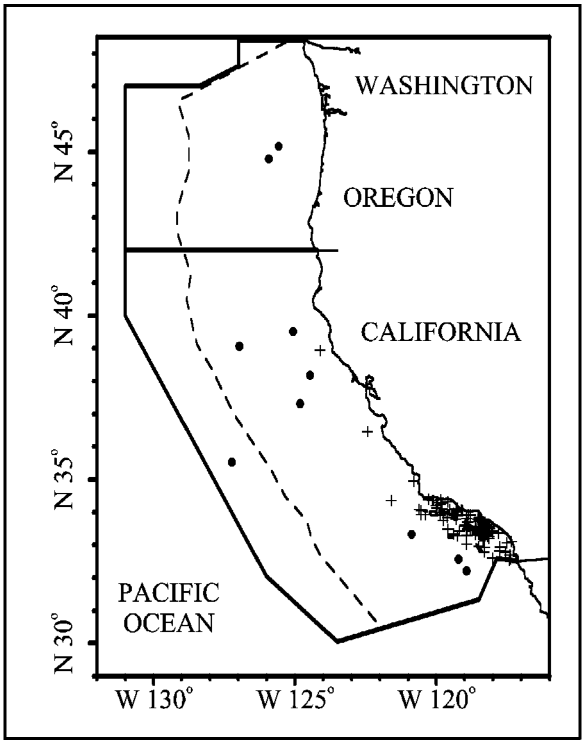

Figure 1. Short-finned pilot whale sightings made during aerial and shipboard surveys conducted off California in 1975-83 (+) and off California, Oregon and Washington, ~~1989-96~~ 1991-96 (●). ~~Greater effort was conducted off California (south of 42°N) and in the inshore half of the U.S. EEZ~~. See Appendix 2, Figures 1-5, ~~of Barlow et al. (1997) and Barlow (1997)~~ 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

~~Based on surveys conducted within 300 nmi of the California, Oregon and Washington coast in 1991, 1993, and 1996, Barlow (1997) has recently calculated an abundance estimate of 970 (CV=0.37) short-finned pilot whales.~~ 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 ~~above~~ 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 (~~Mangels~~ Barlow and Gerrodette 199~~4~~6; 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

~~Based on this stock's unknown status and growth rate and given the precision of the estimate of annual fishery mortality (CV=0.50), the recovery factor (F_r) is 0.48. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 717 yields a potential biological removal (PBR) of 6.9 animals per year.~~ 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~~ of Barlow et al. (1997)~~. ~~The average estimated annual mortality for short-finned pilot whales in this fishery for the five most recent years of monitoring, 1993-97, is 13 (CV=0.50) animals (Julian and Beeson 1998; Julian 1997, Cameron 1998).~~ 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.

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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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.).

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 (~~California Department of Fish and Game, unpubl. data~~ Vojkovich 1998).

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	~~1993~~	~~13.4 %~~	~~8~~	~~60 (0.54)~~	~~13 (0.50)~~
		1994	17.9 %	0	0	
		1995	15.6 %	0	0	
		1996	12.4 %	0	0	3.0 (0.96)[1]
		1997	~~26.6 %~~22.8%	1	6 (0.96)	
		1998	20.2%	0	0	
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						~~13 (0.50)~~ 3.0 (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.

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. ~~Because the average annual human-caused mortality for 1993-97 (13 animals per year) exceeds the PBR (6.9) short-finned pilot whales off California are a "strategic" stock under the MMPA, and the total fishery mortality and injury cannot be considered to be insignificant and approaching zero. A take reduction plan for the drift gillnet fishery, including mandatory pingers and a minimum 6-fathom suspender length, was implemented in 1997, and preliminary results indicate that cetacean mortality has decreased markedly (Cameron 1998).~~ 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.

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Revised ~~08/01/97~~ 01/03/00

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.

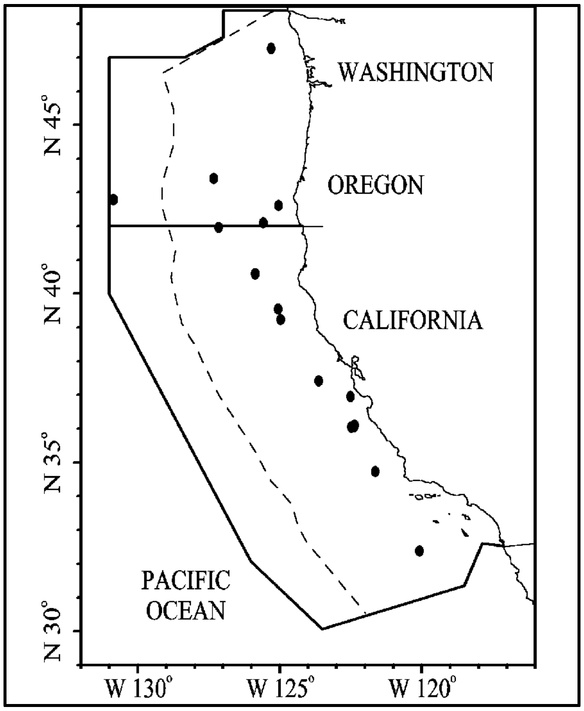

Figure 1. Baird's beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-94~~1991-96 ~~Key: ○= May-October; += November-April~~ (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

POPULATION SIZE

~~Although Baird'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. Recently, Barlow and Gerrodette (1996) have combined data from two surveys conducted in 1991 and 1993 along the California coast, resulting in an estimate of 380 (CV=0.53) Baird's beaked whales. However, this estimate is probably biased downward by an unknown amount because of the large proportion of time this species spends submerged, and because the ship surveys covered only California waters and thus could not observe animals off Oregon/Washington. After analysis of data from a comprehensive shipboard survey conducted along the entire coast of California, Oregon and Washington in the summer of 1996 (NMFS, Southwest Fisheries Science Center), an abundance estimate for the entire defined stock range will be available. In addition, studies of the proportion of time this species spends diving will be needed to obtain more accurate abundance estimates for Baird's beaked whales in the future.~~ 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

~~Based on the above abundance estimate and CV, the minimum population estimate (defined as the log-normal 20th percentile of the abundance estimate) for Baird's beaked whales in California, Oregon, and Washington is 252 animals.~~ The log-normal 20th percentile of the 1991-96 weighted average abundance estimate is 313 Baird's beaked whales. ~~As with the best population estimate above, this value is probably an underestimate, but the degree of inaccuracy is unknown.~~

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

~~Based on this stock's unknown status and growth rate and given the precision of the estimate of annual fishery mortality (CV=1.00), the recovery factor (F_r) is 0.4. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 252 yields a potential biological removal (PBR) of 2.0 animals per year.~~ 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.

~~ANNUAL~~ 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. ~~In the California drift gillnet fishery, one Baird’s beaked whale was observed taken in 1991-95 (Julian and Beeson, in press). Furthermore, three unidentified beaked whales and three unidentified whales/cetaceans were reported entangled in drift gillnets off California, and one or more of these could have represented this species. The observed average rate of kill for Baird’s beaked whales in 1991-95 is 1/3,125 = 0.0003 whales per fishing day, or one whale every 3,125 fishing days (Julian and Beeson, in press). The average estimated annual mortality for Baird’s beaked whales in this driftnet fishery for the five most recent years of monitoring, 1991-95, is 1.2 (CV=1.00) animals.~~ 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	~~1991~~ ~~1992~~ ~~1993~~ 1994 1995 1996 1997 1998	~~9.8%~~ ~~13.6%~~ ~~13.4%~~ 17.9% 15.6% 12.4% 23.0% 20.0%	~~0~~ ~~0~~ ~~0~~ 1 0 0 0 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 overall cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

~~Similar d~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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. ~~The estimated average annual human-caused mortality for 1991-95 (1.2 animals) is less than the PBR (2.0), and therefore Baird's beaked whales are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury is over half of the PBR and therefore cannot be considered to be insignificant and approaching zero.~~ 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’ 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.

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Revised ~~12/15/98~~ 01/03/00

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.

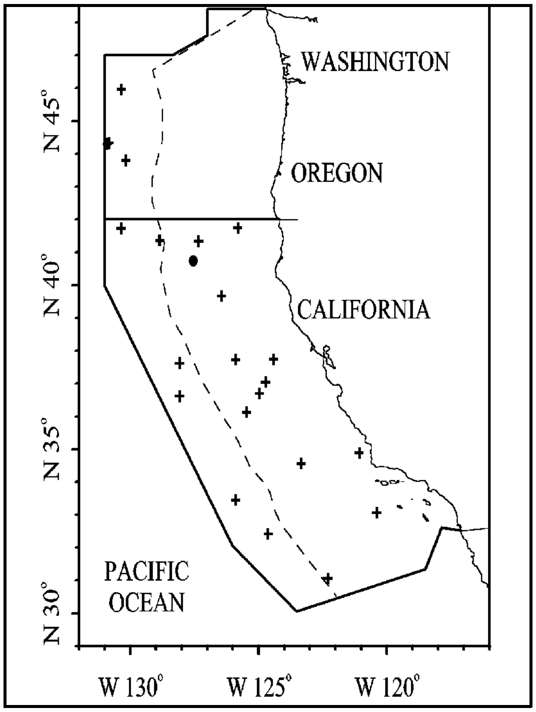

Figure 1. *Mesoplodon* beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-1994~~ 1991-96 ~~Key: O=*Mesoplodon* sp.; += *Mesoplodon carlhubbsi*; ×=*Mesoplodon densirostris*~~ (see Appendix 2, Figures 1-5, ~~in Barlow et al. 1997 Appendix 2~~ for 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 ~~in 1991, 1993, and 1996 within 300 nmi of the California coast~~ 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) ~~and 4) conducting surveys off Oregon and Washington in summer/fall 1996. Furthermore, the.~~ 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 ~~Combining the average 1991-96 abundance estimates in Barlow (1997) with the correction factor estimated by Barlow and Sexton (1996), the new estimates of abundance~~ are 3,738 (CV=~~0.46~~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=~~0.46~~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 ~~2,840~~ 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

~~Based on the unknown status and growth rate of mesoplodont beaked whales, and given the precision of the estimate of annual fishery mortality (CV≈0.65), the recovery factor (F_r) is 0.45. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 2,840 yields a potential biological removal (PBR) of 26 mesoplodont beaked whales per year, including at least 1.1 Blainville's beaked whales per year.~~ 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~~ of Barlow et al. (1997~~). 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~~s are~~ is likely to have been a *Mesoplodon* sp~~p~~. ~~The average estimated annual mortality for all mesoplodont beaked whales in this fishery for the five most recent years of monitoring, 1992-96 , is 9.2 (CV=0.65) if only animals identified to the genus *Mesoplodon* are included, or 13 (CV=0.66) if the "unidentified beaked whales" are considered to have been mesoplodont beaked whales (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, 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.

~~Similar d~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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 *Mesoplodon* beaked whales (California/Oregon/Washington Stocks) in commercial fisheries that might take these species ~~(Julian 1997; Julian and Beeson, in press)~~. 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	~~1992~~	~~13.6%~~	~~3~~	~~22 (0.53)~~	
		~~1993~~	~~13.4%~~	~~0~~	~~0~~	~~6.6 (0.67)~~
		1994	17.9%	2	11 (0.64)	
		1995	15.6%	0	0	0[1]
		1996	12.4%	0	0	
		1997	23.0%	0	0	
		1998	20.0%	0	0	
	Stejneger's beaked whale, *Mesoplodon stejnegeri*					
	observer data	~~1992~~	~~13.6%~~	~~0~~	~~0~~	
		~~1993~~	~~13.4%~~	~~0~~	~~0~~	~~1.2 (1.00)~~
		1994	17.9%	1	6 (0.91)	
		1995	15.6%	0	0	0[1]
		1996	12.4%	0	0	
		1997	23.0%	0	0	
		1998	20.0%	0	0	
	~~Unidentified *Mesoplodon* beaked whale~~					
	~~observer data~~	~~1992~~	~~13.6%~~	~~1~~	~~7 (0.93)~~	
		~~1993~~	~~13.4%~~	~~0~~	~~0~~	
		~~1994~~	~~17.9%~~	~~0~~	~~0~~	~~1.4 (1.00)~~
		~~1995~~	~~15.6%~~	~~0~~	~~0~~	
		~~1996~~	~~12.4%~~	~~0~~	~~0~~	
	Unidentified beaked whale (probably *Mesoplodon*)					
	observer data	~~1992~~	~~13.6%~~	~~2~~	~~15 (0.65)~~	
		~~1993~~	~~13.4%~~	~~0~~	~~0~~	~~4.2 (0.70)~~
		1994	17.9%	1	6 (0.90)	
		1995	15.6%	0	0	0[1]
		1996	12.4%	0	0	
		1997	23.0%	0	0	
		1998	20.0%	0	0	
Minimum total annual takes of *Mesoplodon* beaked whales						~~9.2 (0.65) to 13 (0.66)~~ 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.

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 deep-diving cetacean species, such as mesoplodont beaked whales (Richardson et al. 1995). None of the five species is listed as "threatened" or "endangered" under the Endangered Species Act nor considered "depleted" under the MMPA. ~~The estimated annual human-caused mortality in 1992-96 for all mesoplodont beaked whales combined (9.2) plus all unidentified beaked whales (4.2) is less than the PBR (26); therefore, this group of species is not classified as a "strategic" stock as defined by the MMPA. The total fishery mortality and serious injury for all mesoplodont beaked whales exceeds 10% of the PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.~~ 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.

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Revised ~~08/01/97~~ 01/03/00

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.

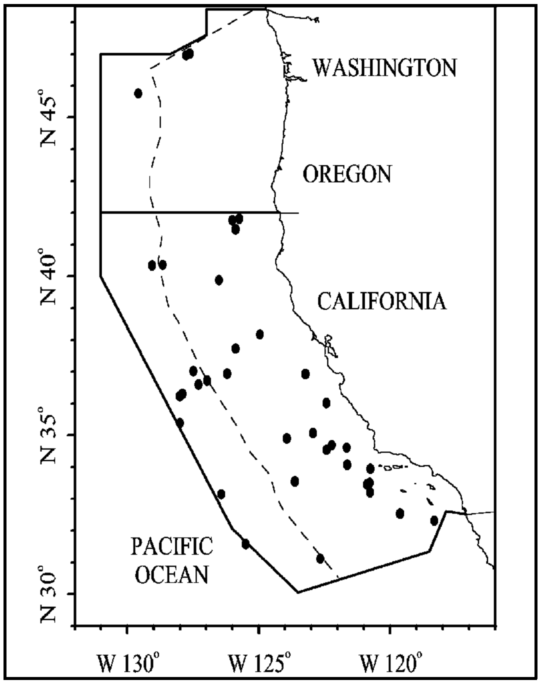

Figure 1. Cuvier's beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-94~~1991-96 (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates 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 ~~two~~ three surveys conducted ~~in 1991 and 1993 within 300 nmi of the California coast~~ 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 ~~Combining the abundance estimate in Barlow and Gerrodette (1996) with the correction factor estimated by Barlow and Sexton (1996), the new estimate of abundance is 9,163 (CV=0.52)~~ is 5,870 (CV=0.38) Cuvier's beaked whales (Barlow 1997, with corrected CV). ~~This estimate is probably still biased downward by an unknown amount, however, because the surveys did not cover Oregon and Washington waters. After the completion of analyses for the comprehensive shipboard survey conducted along the entire coast of California, Oregon and Washington in the summer of 1996 (NMFS, Southwest Fisheries Science Center), relatively unbiased abundance estimates for the entire defined stock range will be available.~~

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 ~~6,070~~ 4,309 animals. ~~This estimate may still be biased low because the surveys did not cover Oregon and Washington waters.~~

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

~~Based on this stock's unknown status and growth rate, the recovery factor (F_r) is 0.5, and ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 6,070 yields a potential biological removal (PBR) of 61 animals per year.~~ 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.

~~ANNUAL~~ 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. ~~In the California drift gillnet fishery, the observed average rate of kill for Cuvier's beaked whales in 1991-95 is 20/3,125 = 0.0064 whales per fishing day, or one every 156 fishing days (Julian and Beeson, in press). One animal was release alive in 1995. Three unidentified beaked whales and three unidentified cetaceans, which may have been Cuvier's beaked whales, were also reported killed. The average estimated annual mortality for Cuvier's beaked whales in this fishery for the five most recent years of monitoring, 1991-95, is 28 (CV=0.28) if the animal released alive is included, or 26 (CV=0.28) if it is excluded.~~ 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~~; annual take estimates include this animal (if it were excluded, mean annual takes for 1991-95 would be 26, CV=0.28~~). 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	~~1991~~	~~9.8%~~	~~0~~	~~0~~	
		~~1992~~	~~13.6%~~	~~6~~	~~44 (0.36)~~	~~28 (0.28)~~
		~~1993~~	~~13.4%~~	~~3~~	~~22 (0.53)~~	
		1994	17.9%	6	34 (0.36)	
		1995	15.6%	5+1	32 (0.40) / 39 (0.36)	0[1]
		1996	12.4%	0	0	
		1997	23.0%	0	0	
		1998	20.0%	0	0	
Minimum total annual takes ~~1991-95, including animal released alive~~						~~28 (0.28)~~ 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.

~~Similar d~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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). 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 ~~The average annual human-caused mortality (28 animals, or 26 animals if the individual released alive is excluded) is estimated to be less than the PBR (61), and therefore Cuvier's beaked whales are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for Cuvier's beaked whales during 1991-95 is greater than 10% of the calculated PBR and, therefore, cannot be~~ considered to be insignificant and approaching zero ~~mortality and serious injury rate~~.

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Revised ~~08/01/97~~ 01/03/00

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; ~~ODFG~~ 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.

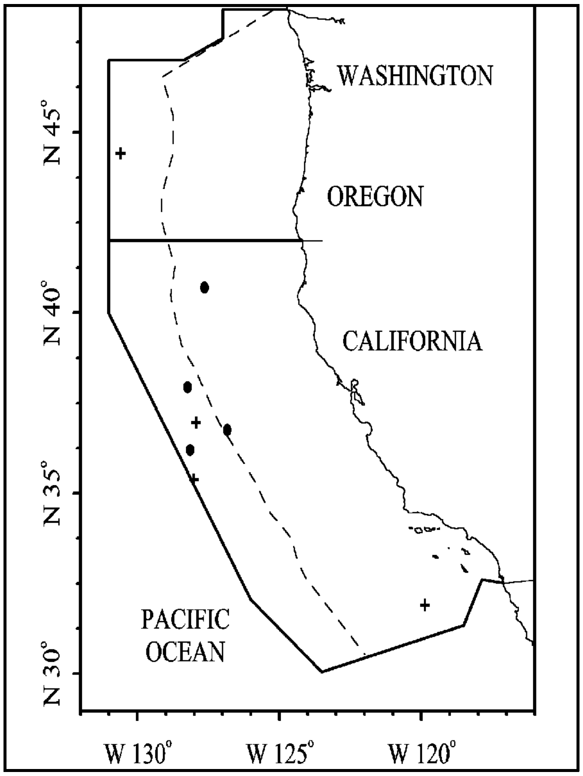

Figure 1. *Kogia* sightings based on aerial and shipboard surveys off California, Oregon and Washington, ~~1975-1994~~1991-96 ~~Key: ○ = *Kogia breviceps*; × = *Kogia* sp.~~ (see Appendix 2, Figures 1-5, for data sources and information on timing and location of survey effort). Key: ● = *Kogia breviceps*, + = *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 ~~two~~ three surveys conducted ~~in 1991 and 1993 within 300 nmi of the California coast~~ 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 ~~Combining the abundance estimate in Barlow and Gerrodette (1996) with the correction factor estimated by Barlow and Sexton (1996), the new estimate of abundance is 3,145 (CV=0.54)~~ is 2,933 (CV=0.54) pygmy sperm whales ~~Additionally, there are~~ plus an estimated ~~891 (CV=2.04)~~ 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). ~~These estimates are probably still biased downward by an unknown amount, however, because the surveys did not cover Oregon and Washington waters. After the completion of analyses for a comprehensive shipboard survey conducted along the entire coast of California, Oregon and Washington in the summer of 1996 (NMFS, Southwest Fisheries Science Center), relatively unbiased abundance estimates for the entire defined stock range will be available.~~

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 ~~2,059~~ 2,837 animals. ~~This estimate may still be biased low because the surveys only covered California waters, and because most of the unidentified *Kogia* may have been pygmy sperm 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.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this species.

POTENTIAL BIOLOGICAL REMOVAL

~~Based on this stock's unknown status and growth rate and given the precision of the estimate of annual fishery mortality (CV=0.61), the recovery factor (F_r) is 0.45. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 2,059 yields a potential biological removal (PBR) of 19 animals per~~ year. 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.

~~ANNUAL~~ 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~~se fisheries~~ drift gillnet fishery is provided in Appendix 1. ~~Between January 1991 and December 1995, one pygmy sperm whale was recorded killed in the California drift gillnet fishery (Julian and Beeson, in press). Additionally, one unidentified *Kogia* and three unidentified cetaceans, which may have been pygmy sperm whales, were reported in the driftnet fishery. The observed average rate of kill for pygmy sperm whales in 1991-95 is 1/3,125 = 0.0003 whales per fishing day, or one every 3,125 fishing days (Julian and Beeson, in press). It is likely that the unidentified *Kogia* was also a pygmy sperm whale, rather than the dwarf sperm whale, *Kogia simus*, because there have been no records of dwarf sperm whales off the U.S. west coast since 1981. Including this unidentified *Kogia*, the average estimated annual mortality for pygmy sperm whales in this fishery for the five most recent years of monitoring, 1991-95, is 2.8 (CV=0.61) animals~~ 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.

~~Similar d~~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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~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 pygmy sperm whales and unidentified *Kogia* sp. (California/Oregon/Washington Stock) in commercial fisheries that might take ~~these~~ this species. ~~All observed entanglements 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 *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	~~1991~~	~~9.8%~~	~~0 / 0~~	~~0 / 0~~	~~2.8 (0.61)~~
		~~1992~~	~~13.6%~~	~~0 / 1~~	~~0 / 7 (0.92)~~	
		~~1993~~	~~13.4%~~	~~1 / 0~~	~~7 (0.93) / 0~~	
		1994	17.9%	0 / 0	0 / 0	0[1]
		1995	15.6%	0 / 0	0 / 0	
		1996	12.4%	0 / 0	0 / 0	
		1997	23.0%	0 / 0	0 / 0	
		1998	20.0%	0 / 0	0 / 0	
Minimum total annual takes ~~of pygmy sperm whales, 1991-95 (incl. unidentified *Kogia*)~~						~~2.8 (0.61)~~ 0 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.

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. ~~The average annual human-caused mortality of pygmy sperm whales and unidentified *Kogia* (2.8 animals) is estimated to be less than the PBR (19), and therefore pygmy sperm whales are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for pygmy sperm whales and unidentified *Kogia* is greater than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.~~

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~~Revised 08/01/97~~

~~DWARF SPERM WHALE (*Kogia simus*):~~
~~California/Oregon/Washington Stock~~

[Too rare to justify a stock assessment report for the U.S. West Coast. There have been no records (sightings, strandings or fishery mortality) of this species off the U.S. West coast since the early 1970s]

~~STOCK DEFINITION AND GEOGRAPHIC RANGE~~

~~Dwarf sperm whales are distributed throughout deep waters and along the continental slopes of the North Pacific and other ocean basins (Caldwell and Caldwell 1989; Ross 1984). This species was only recognized as being distinct from the pygmy sperm whale in 1966 (Handley, 1966), and early records for the two species are confounded. Along the U.S. west coast, no at-sea sightings of this species have been reported; however, this may be partially a reflection of their pelagic distribution, small body size and cryptic behavior. A few sightings of animals identified only as *Kogia* sp. have been reported (Figure 1), and some of these may have been dwarf sperm whales. At least three dwarf sperm whales stranded in California between 1967 and 1981 (Roest 1970; Jones 1981; J. Heyning, pers. comm.), and one stranding is reported for western Canada and (Nagorsen and Stewart 1983). It is unclear whether records of dwarf sperm whales are so rare because they are not regular inhabitants of this region, or merely because of their cryptic habits and offshore distribution. Available data are insufficient to identify any seasonality in the distribution of dwarf sperm whales, or to delineate possible stock boundaries. For the Marine Mammal Protection Act (MMPA) stock assessment reports, dwarf 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.~~

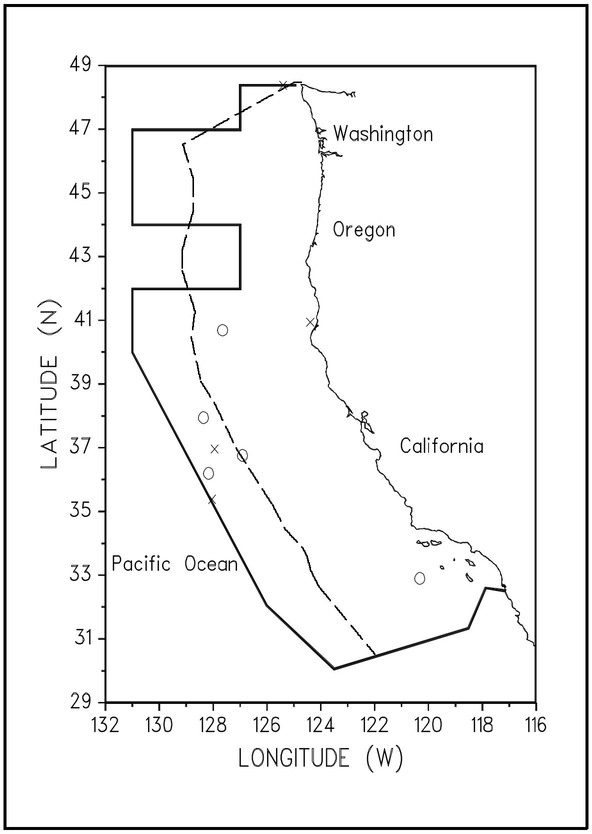

Figure 1. ~~*Kogia* sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-1994. Key: ○ = *Kogia breviceps*; × = *Kogia* sp. (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.~~

~~POPULATION SIZE~~

~~No information is available to estimate the population size of dwarf sperm whales off the U.S. west coast, and the lack of sighting or stranding records since 1981 makes it is unclear whether their current distribution includes this region. Based on sightings that could only be identified to the genus *Kogia* during 1991 and 1993 shipboard surveys, there are an estimated 891 (CV=2.04) pygmy~~ or ~~dwarf sperm whales along the California coast. This estimate is derived from the abundance estimates recently calculated by Barlow and Gerrodette (1996), and includes a correction for the fraction of animals missed because they are submerged, based on dive interval data collected for *Kogia simus* in the Gulf of California in 1996 (Barlow and Sexton 1996).~~

~~Minimum Population Estimate~~

~~No information is available to obtain a minimum population estimate for dwarf sperm whales.~~

~~Current Population Trend~~

~~Due to the rarity of records for this species 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~~

~~Based on this stock's unknown status and growth rate, the recovery factor (F_r) is 0.5, and ½R_{max} is the default value of 0.02. However, due to the lack of abundance estimates for this species, no potential biological removal (PBR) can be calculated.~~

~~ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY~~

~~Fishery Information~~

~~Based on their small body size and patterns of take for other cetaceans, dwarf sperm whales may be susceptible to mortality in California drift gillnet fisheries. More detailed information on these fisheries is provided in Appendix 1. Between January 1991 and December 1995, no dwarf sperm whales were recorded killed in driftnets (Julian and Beeson, in press). However, one unidentified *Kogia* and three unidentified cetaceans, which may have been dwarf sperm whales, were reported in the driftnet fishery (Table 1). The observed average rate of kill for unidentified *Kogia* whales in 1991-95 is 1/3,125 = 0.0003 whales per fishing day, or one every 3,125 fishing days (Julian and Beeson, in press). Because of the lack of sighting or stranding records of dwarf sperm whales along the U.S. west coast since 1981, it is likely that the unidentified *Kogia* was a pygmy sperm whale, *Kogia breviceps*, rather than a dwarf sperm whale.~~

~~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, 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 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.~~

~~**Table 1.** Summary of available information on the incidental mortality and injury of unidentified *Kogia* (pygmy or dwarf sperm whales, California/Oregon/ Washington Stocks) in commercial fisheries that might take these species. The single observed entanglement resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses.~~

~~**Fishery Name**~~	~~**Data Type**~~	~~**Year(s)**~~	~~**Percent Observer Coverage**~~	~~**Observed Mortality**~~	~~**Estimated Annual Mortality**~~	~~**Mean Annual Takes 1991-95**~~
~~**CA/OR thresher shark/swordfish drift gillnet fishery**~~	~~Pygmy or dwarf sperm whales, *Kogia* spp.~~					
	~~observer data~~	~~1991~~	~~9.8%~~	~~0~~	~~0~~	
		~~1992~~	~~13.6%~~	~~1~~	~~7 (0.92)~~	
		~~1993~~	~~13.4%~~	~~0~~	~~0~~	
		~~1994~~	~~17.9%~~	~~0~~	~~0~~	
		~~1995~~	~~15.6%~~	~~0~~	~~0~~	~~1.4 (1.00)~~
~~**Minimum total annual takes of unidentified *Kogia*, 1991-95**~~						~~1.4 (1.00)~~

~~STATUS OF STOCK~~

~~The status of dwarf 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 dwarf 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. Given that this species currently does not appear to occur off the U.S. west coast and given the greater likelihood that the unidentified *Kogia* mortality (1.4 animals per year) represents the pygmy sperm whale (which has been documented in this region), dwarf sperm whales off California, Oregon and Washington are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock cannot presently be evaluated in relation to a zero mortality and serious injury rate.~~

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Revised ~~09/30/99~~ 01/03/00

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 ~~three~~ 176 sperm whales that were marked with Discovery tags off southern California in ~~January~~ winter 1962-70, only three were recovered by whalers: one ~~was caught by whalers~~ 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). ~~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.~~ 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., in press).

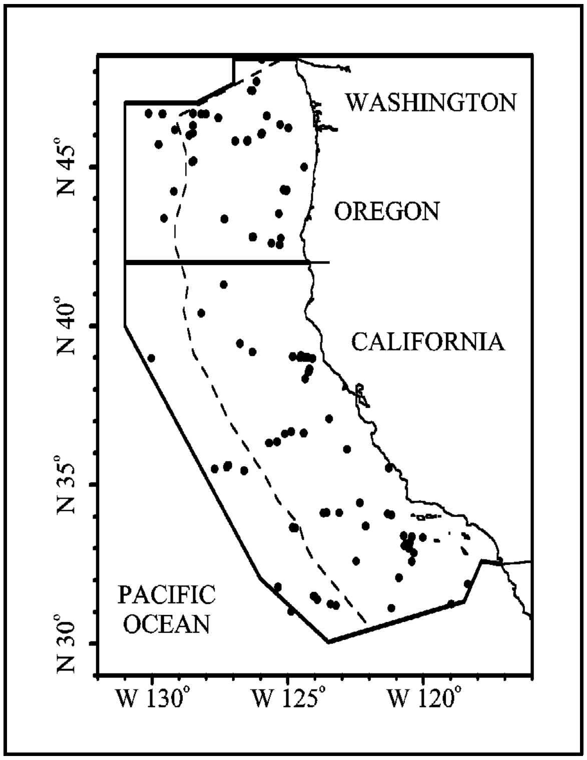

Figure 1. Sperm whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1989-96. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. Greater effort was conducted off California (south of 42˚N) and in the inshore half of the U.S. EEZ. See Appendix 2 of Barlow et al. (1997) and Barlow (1997) 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 (1997) estimates 1,191 (CV=0.22) sperm whales along the coasts of California, Oregon, and Washington during summer/fall based on ship line transect surveys in 1991, 1993, and 1996 (lognormal 95% C.I.= 778-1,824). Forney et al. (1995) estimate 892 (CV=0.99) sperm whales off California during winter/spring based on aerial line-transect surveys (95% C.I.=176-4,506), but this estimate does not correct for diving whales that were missed. Because of the long dive time of sperm whales (Leatherwood et al. 1982), it is reasonable to assume that a corrected estimate ~~the true abundance~~ would be three to eight times the estimates from aerial surveys. 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.

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 ~~within the area of the drift gillnet fishery~~ for this stock is therefore from the ship survey estimate of Barlow (1997); however, this is probably an underestimate of true abundance because recent studies suggest sperm whale group sizes may have been underestimated on past line-transect surveys (Barlow and Taylor 1998; B. Taylor, unpubl. data).

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 1997) or approximately 992. 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 ~~fairly stable in~~ rather variable off California ~~coastal waters~~ 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 (992) 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 2.0.

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.~~ Sperm whales in this stock are likely to be caught only in offshore drift gillnets.~~ Detailed information on this fishery is provided in Appendix 1~~ of Barlow et al. (1997)~~. A 1994-98 summary of known fishery mortality and injury for this stock of sperm whales is given in Table 1. ~~In 1996-97, a pinger experiment was conducted to evaluate whether these acoustic alarms may reduce cetacean entanglement rates in the drift gillnet fishery. Based on the positive results of this study (Cameron 1998), pingers were made mandatory in this fishery in November 1997.~~ 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 1997-98 data. This results in an average estimate of 2.5 (CV = 0.89) sperm whale mortalities per year.~~ The 1996-97 mortality estimates were stratified for pingered and unpingered drift gillnets. Only one whale was observed in a pingered net in 1996; this whale sustained significant injuries and was not expected to survive (Cameron 1998). The average annual fishery mortality is estimated to be 3.0 sperm whales for the five most recent years of monitoring (1993-97). In addition, an estimated 1.6 sperm whales per year were entangled but released alive. In addition, some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net. The deaths of two stranded sperm whales in California were attributed to entanglement in fishing gear between 1983 and 1991 (J. Cordaro, pers. comm.).~~

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 ~~1998~~ 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 ~~1993-97~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1993~~ 1994 1995 1996 1997 1998	observer data	~~13.4%~~ 17.9% 15.6% 12.4% ~~26.6~~ 23.0% 20.0%	~~2 (1)~~ 0 0 0 (1) 0 1	Mortality ~~15,~~0,0,0,0,5 ~~(0.66,0)~~ (0.89) Injury ~~7,~~0,0,1,0,0	Mortality ~~3.0 (0.66)~~ 2.5 (0.89)[1] Injury ~~1.6 (n/a)~~ 0.0 (n/a)
Total annual takes						~~4.6 (0.66)~~ 2.5 (0.89)

[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 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~, in press~~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.). ~~Ship strikes were implicated in the deaths of two unidentified whales in 1990 (J. Cordaro, 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.~~

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 (~~3.0~~2.5 per year) is greater than the calculated PBR for this stock (2.0) which would also result in the classification of this stock as “strategic”. ~~In addition, an annual average of 1.6 sperm whales are estimated to be entangled and injured, but released alive.~~Total fishery takes are ~~mortality is~~ not approaching zero mortality and serious injury rate. ~~In comparing gillnet mortality with the PBR, it should be remembered that the PBR does not include sperm whales found further offshore which possibly belong to the same population. A fishery interaction problem appears to exist for sperm whales taken in the drift gillnet fishery, but enough uncertainties exist that one should not conclude from this information that sperm whales are necessarily declining in abundance off the U.S. West Coast. A take reduction plan for the drift gillnet fishery, including mandatory pingers and a minimum 6-fathom suspender length, was implemented in 1997, and preliminary results indicate that cetacean mortality has decreased markedly (Cameron 1998).~~ 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”.

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Revised ~~09/30/99~~01/03/00

HUMPBACK WHALE (*Megaptera novaeangliae*): California/Oregon/Washington - Mexico Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

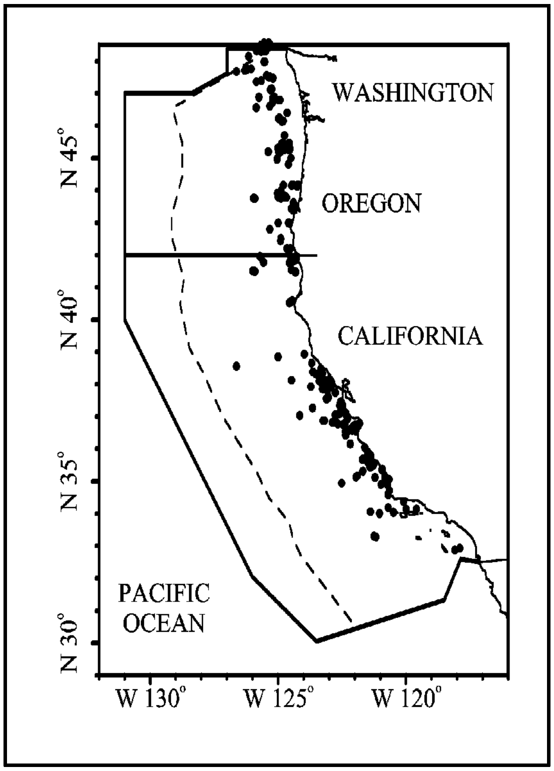

Figure 1. Humpback whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1989-96. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. Greater effort was conducted off California (south of 42˚N) and in the inshore half of the U.S. EEZ. See Appendix 2 of Barlow et al. (1997) and Barlow (1997) for data sources and information on timing and location of survey effort.

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. 1997, 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 California/ Oregon/Washington - Mexico 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. 1997) - 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; ~~, but~~ the migratory destination of these whales is not well known (Calambokidis et al. 1993, Calambokidis et al. 1997), but Norris et al. (1999) speculate that they may travel to the Bering Sea or Aleutian Islands. 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 California/Oregon/Washington - Mexico 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). Dohl et al. (1983) first estimated the central California feeding population to be 338 (CV=0.29) based on aerial surveys in August through November of 1980-83; however, this estimate does not include a correction for submerged animals. More recently, the size of the "California" feeding stock of humpback whales has been estimated by three independent methods. 1) Calambokidis et al. ~~(1998)~~ (1999) estimated the number of humpback whales in California-Washington to be ~~843~~ 905 (CV=0.06) based on mark-recapture estimates comparing their ~~1996 and~~ 1997 and 1998 photo-identification catalogs. 2) Barlow (1997) estimates 1,152 (CV=0.15) humpbacks in California, Oregon and Washington waters based on ship line-transect surveys in summer/autumn of 1991, 1993, and 1996. 3) Forney et al. (1995) estimate 319 (CV=0.41) humpback whales in California coastal waters based on aerial line-transect surveys in winter/spring of 1991 and 1992 (not corrected for diving whales). In addition, Green et al. (1992) report that humpback whales were the second most abundant large whale (after the gray whale) in aerial surveys off Oregon and Washington, but they did not estimate population size. These estimates for the west-coast stock are not significantly different from each other, The shipboard estimates are likely to be the most unbiased, and the aerial surveys are likely to be the most negatively biased because submerged animals are missed. Mark-recapture estimates may also be negatively biased due to heterogeneity in sighting probabilities (Hammond 1986). However, given that the above mark-recapture estimate is based on a large fraction of the entire population (the ~~1996-97~~ 1997-98 catalog contained ~~492~~ 544 known individuals), this bias is likely to be minimal. Also, in previous mark-recapture analyses on the same population, when methods were used which account for heterogeneity, estimates were comparable or smaller (Calambokidis et al. 1993). The most precise and least biased estimate is likely to be the mark-recapture estimate of ~~843~~ 905 (CV=0.06) humpback whales for this population.

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 ~~1996-97~~ 1997-98 abundance estimated from mark-recapture methods (Calambokidis et al. ~~1998~~1999) or approximately ~~802~~861.

Current Population Trend

~~There is~~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 ~~1993~~1996 (Barlow 1997). ~~and Gerrodette 1996), but these trends are not statistically significant.~~ Mark-recapture population estimates increased steadily from 1988/90 to ~~1992/93~~1997-98 at about ~~5%~~8% per year (Calambokidis et al. 1999). ~~and Steiger 1994), and the even higher 1996-97 estimate suggests a continued population increase (Calambokidis et al. 1998). Although the population in the North Pacific is expected to have grown since being given protected status in 1966, the possible effects of continued unauthorized take (Yablokov 1994) and incidental ship strikes and gillnet mortality make this uncertain.~~ 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 California/Oregon/Washington stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

~~There are no estimates of the growth rate of humpback whale populations in the North Pacific (Best 1993)~~. 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. 1999) 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 (861) ~~(802)~~ times one half the estimated population growth rate for this stock of humpback whales (1/2 of 8%) ~~default maximum net growth rate for cetaceans (1/2 of 4%)~~ times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of 3.4 ~~1.6~~. Because this stock spends approximately half its time ~~in Mexican waters~~ outside the U.S. EEZ, the PBR allocation for U.S. waters is 1.7 ~~0.8~~ 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, pers. comm.). 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

~~Humpback whales are known to be killed only in offshore drift gillnets.~~ A 1994-98 summary of known fishery mortality and injury for this stock of humpback whales is given in Table 1. Detailed information on ~~this fishery~~ these fisheries is provided in Appendix 1. ~~of Barlow et al. (1997). The average fishery mortality and injury is estimated to be 1.4 humpback whales per year for the five most recent years of monitoring (1993-97) based on the observation of one entangled whale (released alive).~~ 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 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)~~. A~~, and a humpback whale was observed off Ventura, CA in 1993 with a 20 ft section of netting wrapped around and trailing behind, but no other gillnet-caused strandings or entanglements were reported for the period 1994-98 (J. Cordero, NMFS SW Region, pers. comm.). 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 (CA/OR/WA - Mexico stock) for commercial fisheries that might take this species (Julian 1997, Julian and Beeson 1998, Cameron ~~1998~~ and Forney 1999). 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 1994-98 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 ~~1993-97~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1993~~ 1994 1995 1996 1997 1998	observer data	~~13.4%~~ 17.9% 15.6% 12.4% ~~26.6%~~ 23.0% 20.0%	~~0~~ 0 (1) 0 0 0 0	Mortality 0,0,0,0,0 Injury ~~0,~~6,0,0,0,0 (0.91)	Mortality 0 Injury ~~1.2 (0.91)~~ 0[1]
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	~~1991-95~~ 1990-94	observer data	10-15%	0,0,0,0,0	0,0,0,0,0	~~0~~ n/a
CA salmon troll fishery	1997	incidental report	0%	(1)	n/a	Injury >0.2 (n/a)
Total annual takes						>0.2

[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 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~, in press~~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 and one humpback whale in 1995, and one unidentified whale, which may have been a humpback whale, was struck and injured by a small boat in 1997 (J. Cordaro, pers. comm.). 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 1994-98 ~~from 1993-97~~ is at least ~~0.6~~ 0.2 per year.

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 "California" 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 (~~1.4/yr)~~(0.2/yr) plus ship strikes ~~(0.6/yr)~~(0.2/yr) in California is less ~~greater~~ than the PBR allocation of ~~0.8~~ 1.7 for U.S. waters. ~~If none of the injuries from fishing gear entanglement resulted in death, the known mortality due to ship strikes alone would not exceed the PBR.~~ In a review of the severity of injury to the humpback whale entangled in 1994, the Pacific Scientific Review Group determined that it this animal was not 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 is not approaching zero mortality and serious injury rate. The California 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.

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BLUE WHALE (*Balaenoptera musculus*): ~~California/Mexico~~ 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). ~~One group of animals migrates from Mexico to feed in California waters from June to November.~~ 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. ~~During this feeding period, there is an apparent hiatus in distribution south of the tip of Baja California (Reilly and Thayer 1990; Wade and Gerrodette 1993) and north of California in Oregon and Washington (Green et al. 1992; Barlow 1995). [Two blue whales were, however, tracked using on a seafloor seismic array approximately 500 km offshore from Astoria, Oregon in August 1990 (McDonald et al. 1994) and may have been part of the California/Mexico stock.] Although there are blue whales near the Costa Rica Dome in the eastern tropical Pacific from June to November,~~ Reilly and Thayer (1990) speculate that ~~these~~ 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). ~~Blue whales are now very common in southern California in June-September (Barlow 1995). Distinctively marked individuals have been shown to move between feeding areas in California and coastal waters of, Mexico, including the Gulf of California (Calambokidis et al. 1990). Strong evidence exists for a separate population that spends winter/spring in Mexican coastal waters and summer/autumn in California waters, and there are no verified links to any other feeding areas.~~ One other stock of North Pacific blue whales (in Hawaiian waters) is recognized in the Marine Mammal Protection Act (MMPA) Stock Assessment Reports.

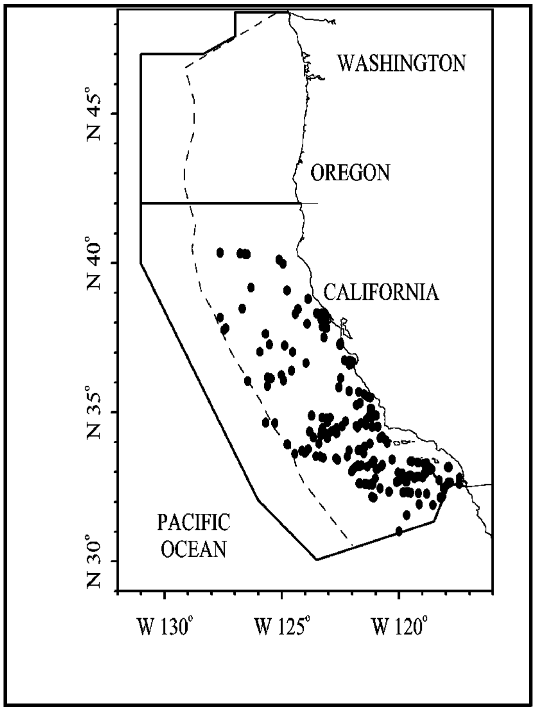

Figure 1. Blue whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, ~~1975-94~~ 1991-96(see Appendix 2, Figures 1-5, for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer 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) ~~and Gerrodette (1996)~~ estimates 1,927 (CV=0.16) ~~1,723 (CV=0.23)~~ blue whales ~~in~~ off California, Oregon, and Washington ~~waters~~ 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) ~~1,785 (CV=0.24). No blue whales were seen in recent aerial and ship surveys off Oregon and Washington (Green et al. 1992), although one or two individuals were known to be present offshore of northern Oregon in August 1990 (McDonald et al. 1994).~~

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 ~~1,463~~.

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 ~~1993~~ (not significant, Barlow 1997 ~~and Gerrodette 1996~~). 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) ~~(1,463)~~ times one half the default maximum net growth rate for cetaceans (1/2 of 4%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of 3.4 ~~2.9~~. Because this stock spends approximately half its time ~~in Mexican waters~~ outside the U.S. EEZ, the PBR allocation for U.S. waters is half this total, or 1.7 ~~1.5~~ 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). ~~Blue whales are likely to be caught only in offshore drift gillnets. A summary of known fishery mortality and injury for this stock of blue 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 blue whales taken annually. ~~The average fishery mortality is estimated to be zero blue whales per year for the five most recent years of monitoring (1991-95).~~ 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.

~~Similar~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California and ~~probably~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~, in press~~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 (~~CA/Mexico~~ Eastern North Pacific stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998~~, in press~~; 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 ~~1991-95~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1991-95~~ 1994-98	observer data	~~10-18%~~ 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 overall cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

Ship Strikes

Ship strikes were implicated in the deaths of blue whales in 1980, 1986, 1987, and 1993~~, plus 2 unidentified whales (possibly blue whales) in 1990~~ (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 ~~0.2~~ per year for 1994-98 ~~from 1991-95~~.

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 ~~California/Mexico~~ 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 1 per year and is therefore 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)~~, particularly for baleen whales that may communicate using low-frequency sound~~.

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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~~1995~~; 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).

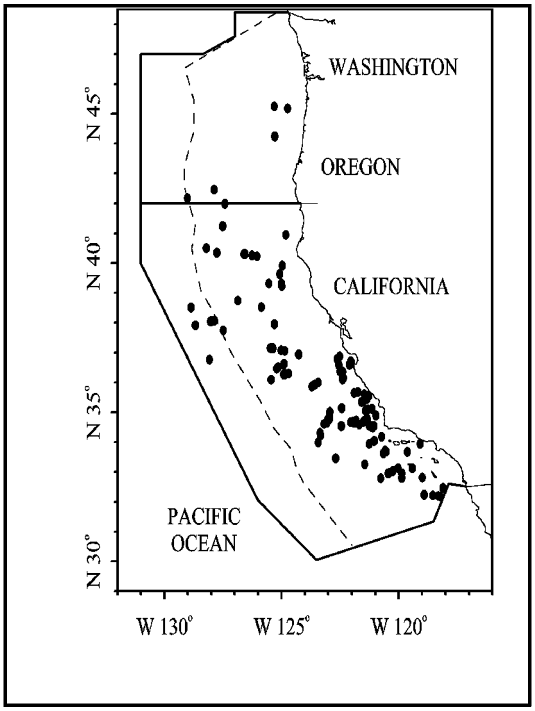

Figure 1. Fin whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, ~~1975-94~~1991-96 (see Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer 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, 1,236 (CV=0.20) ~~933 (CV=0.27)~~ fin whales were estimated to be ~~in~~ off California, Oregon and Washington ~~waters~~ based on ship surveys in summer/autumn of 1991, ~~and~~ 1993, and 1996 ~~(log-normal 95% C.I.=555-1,569)~~ (Barlow 1997~~and Gerrodette 1996~~). Fin whale abundance in California was estimated as only 49 (CV=1.0) based on aerial surveys in winter/spring of 1991/92 (Forney et al. 1995); however, this estimate does not include a correction for diving animals that were missed. ~~No estimates exist for Oregon or Washington, but fin whales were reported to be the fourth most~~

~~abundant large whale in that area (Green et al. 1992).~~

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 1997~~and Gerrodette 1996~~) or approximately 1,044 ~~747~~.

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 ~~1993~~ (Barlow 1997~~and Gerrodette 1996~~), 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 (1,044) ~~(747)~~ times one half the default maximum net growth rate for cetaceans (1/2 of 4%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of 2.1~~1.5~~.

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, but no fishery mortalities or serious injuries have been observed (Table 1). ~~Fin whales are likely to be caught only in offshore drift gillnets. A summary of known fishery mortality and injury for this stock of fin 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 fin whales taken annually. ~~The average fishery mortality is estimated to be zero fin whales per year for the five most recent years of monitoring (1991-95).~~ 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.

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~~, in press~~; 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 ~~1991-95~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1991-95~~ 1994-98	observer data	~~10-18%~~ 12-23%	0,0,0,0,0	0,0,0,0,0	0[1] ~~-~~

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes ~~1991-95~~ (CV in parentheses)
Average annual takes						0

[1] Only 1997-98 mortality estimates are included in the average because overall cetcean entanglement rates dropped considerably after a take reduction plan was implemented in 1997.

~~Similar~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~, in press~~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 one fin whale in 1991, one in 1996, and one in 1997 ~~two unidentified whales (possibly fins) in 1990~~ (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 1994-98.

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 ~~observed~~ total incidental mortality due to fisheries (0.0/yr) and ship strikes (0.4/yr) appears to be less than ~~1 animal per year and is therefore less than~~ the calculated PBR (2.1~~1.5~~). In fact, no fin whale mortality has been associated with California gillnet fisheries; therefore, total fishery mortality is 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.

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Revised ~~8/1/97~~ 01/03/00

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~~and Gerrodette 1996~~). 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.

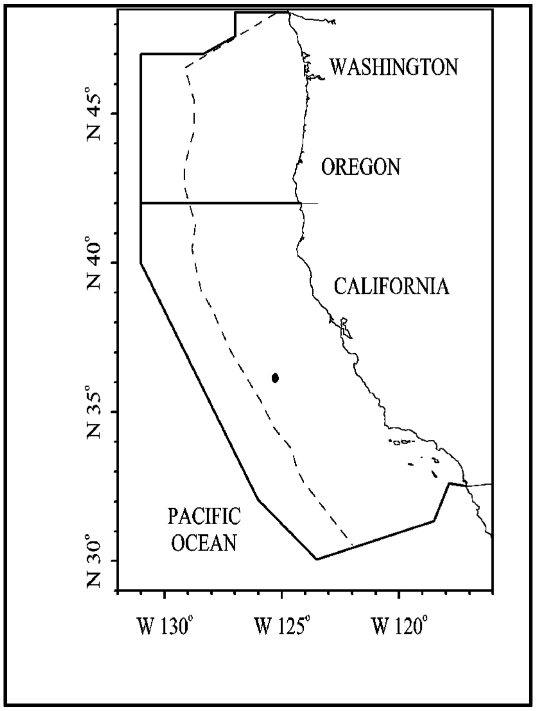

Figure 1. Sighting locations of Bryde's whales ~~(O) and unidentified Bryde's or sei whale (X)~~ based on aerial and shipboard surveys off California, Oregon, and Washington, ~~1975-94~~1991-96 (see Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). ~~and in the eastern tropical Pacific, 1986-90.~~ 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, ~~and~~ 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 ~~24~~ (CV=2.0) (Barlow 1997 ~~and Gerrodette 1996~~).

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. ~~is calculated as the minimum population size (11,163)~~ times ~~one half the default maximum net growth rate for cetaceans (1/2 of 4%)~~ times ~~a recovery factor of 0.5 (for a stock of unknown status), resulting in a PBR of 112. Only 0.2% of the stock is estimated to be in U.S. waters (24 out of 13,000), so the PBR allocation to U.S. waters is only 0.2 Bryde's whales per year.~~

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~~, in press~~; 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 ~~1991-95~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1991-95~~ 1994-98	observer data	~~10-18%~~ 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 overall cetacean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

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). ~~Bryde's whales are likely to be caught only in offshore drift gillnets. A summary of known fishery mortality and injury for this stock of Bryde's 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 Bryde's whales taken annually. ~~The average fishery mortality is estimated to be zero Bryde's whales per year for the five most recent years of monitoring (1991-95).~~ However, some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net.

~~Similar~~ Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California and ~~probably~~ 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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~, in press~~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 ~~does not appear to be greater than 10% of the PBR~~; 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.

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Revised ~~8/1/97~~ 01/03/00

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. ~~The catch has been~~ Whaling effort for this species was distributed continuously across the North Pacific between 45-55ºN (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~~1995~~; 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 180º) will be considered as a separate stock.

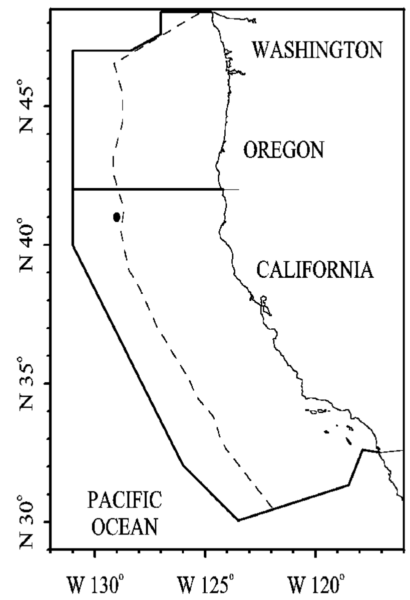

Figure 1. Sei whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, ~~1975-94~~1991-96 (see Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer 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, ~~and~~ 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). ~~Sei whales are likely to be caught only in offshore drift gillnets. A summary of known fishery mortality and injury for this stock of sei 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 sei whales taken annually. ~~The average fishery mortality is estimated to be zero sei whales per year for the five most recent years of monitoring (1991-95).~~ 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~~, in press~~; 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 ~~1991-95~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1991-95~~ 1994-98	observer data	~~10-18%~~ 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 overall cetecean entanglement rates dropped considerably after a Take Reduction Plan was implemented in 1997.

~~Fishery Mortality Rates~~

~~To date, no sei whale mortality has been associated with any eastern North Pacific fisheries; therefore, total fishery mortality is approaching zero mortality and serious injury rate.~~

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.

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Revised ~~12/15/98~~ 01/03/00

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; ~~Barlow 1995~~; 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.

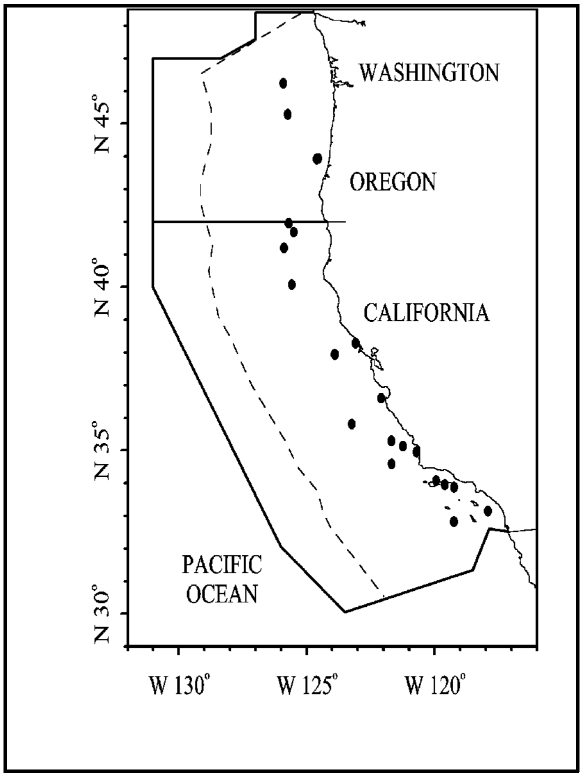

Figure 2. Minke whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, ~~1975-94~~1991-96 (see~~ Barlow et al. (1997)~~ Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold 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 (1/2 of 4%) times a recovery factor of ~~0.45~~ 0.5 (for a stock of unknown status ~~and a mortality CV = 0.67~~), resulting in a PBR of ~~4.0~~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 ~~in press~~; 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 ~~1992-96~~ (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1992~~ ~~1993~~ 1994 1995 1996 1997 1998	observer data	~~13.6%~~ ~~13.4%~~ 17.9% 15.6% 12.4% 23.0% 20.0%	~~0~~ ~~0~~ 1 0 1 0 0	~~0~~ ~~0~~ 6 (0.91) 0 12 (0.96) 0 0	~~3.6 (0.67)~~ 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 ~~1992-96~~	observer data	10-18%	0,0,0,0~~,0~~	0,0,0,0~~,0~~	n/a ~~0~~
Total annual takes						~~3.6 (0.67)~~ 0.0

[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.

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 ~~Barlow et al. (1997,~~ 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. ~~The average fishery mortality is estimated to be 3.6 (CV=0.67) minke whales per year for the five most recent years of monitoring(1992-96).~~ 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.

~~Similar~~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 ~~has~~ increased from two vessels in 1986 to ~~29~~ 31 vessels in ~~1992~~ 1993 (~~Sosa-Nishizaki et al. 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~~, in press~~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 ~~and 2 unidentified whales (possibly minke whales) in 1990~~ (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". ~~For the past five years,~~ The annual mortality due to fisheries (0.0/yr) and ship strikes ~~(3.6)~~ (0.0/yr) is less than the calculated PBR for this stock (~~4.0~~4.4), so they are not considered a "strategic" stock under the MMPA. Fishery mortality ~~alone is greater~~ is less than 10% of the PBR; therefore, total fishery mortality is ~~not~~ 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.

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Revised ~~6/30/95~~ 01/03/00

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.

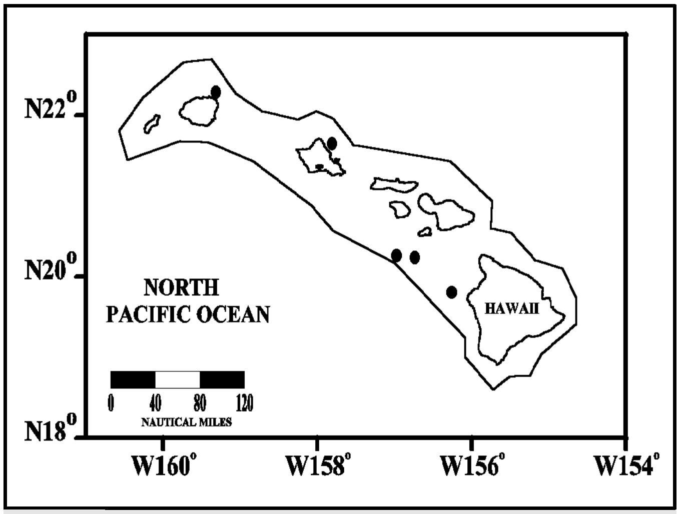

Figure 1. Rough-toothed dolphin sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

A population estimate for this species has been made in the eastern tropical Pacific (Wade and Gerrodette 1993), but ~~there are no data for a population estimate in Hawaiian waters.~~ 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. 1999). 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

~~No data are available for a 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

~~No PBR can be calculated for this species at this time.~~ 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

Other ~~Mortality~~ Removals

At least 22 rough-toothed dolphins were live-captured in Hawaiian waters between 1963 and 1976 (Shallenberger 1981).

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of rough-toothed dolphins is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The~~

~~stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~non-~~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.

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Revised ~~6/30/95~~ 01/03/00

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. ~~In press~~ 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.

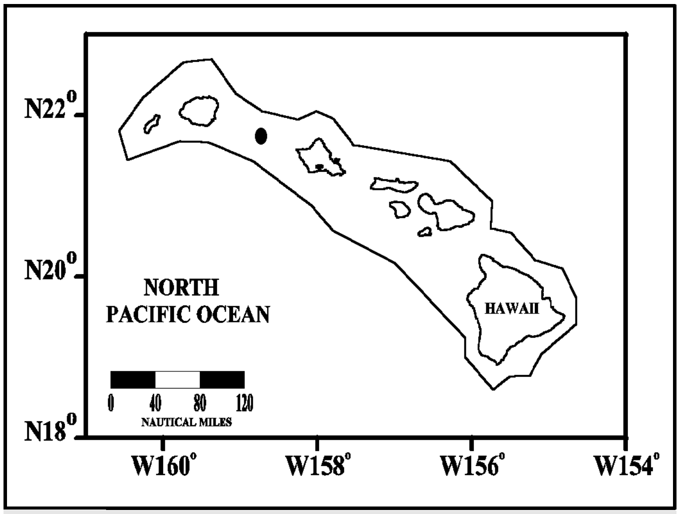

Figure 1. Sighting location for the single Risso's dolphin seen during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Population estimates have been made off Japan (Miyashita 1993) and in the eastern tropical Pacific (Wade and Gerrodette 1993), but ~~there are no data for a population estimate in Hawaiian waters.~~ 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. 1999). 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

Interactions with cetaceans have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), ~~but no interactions with Risso's dolphins have been documented~~ 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 seriously 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.

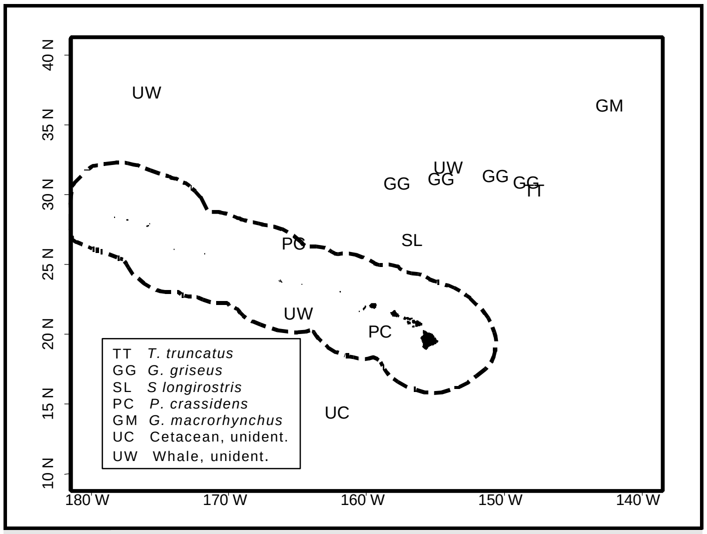

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); GG = Risso's dolphin.

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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of Risso's dolphins is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~non-~~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. However, 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.

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Revised ~~6/30/95~~ 01/03/00

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.

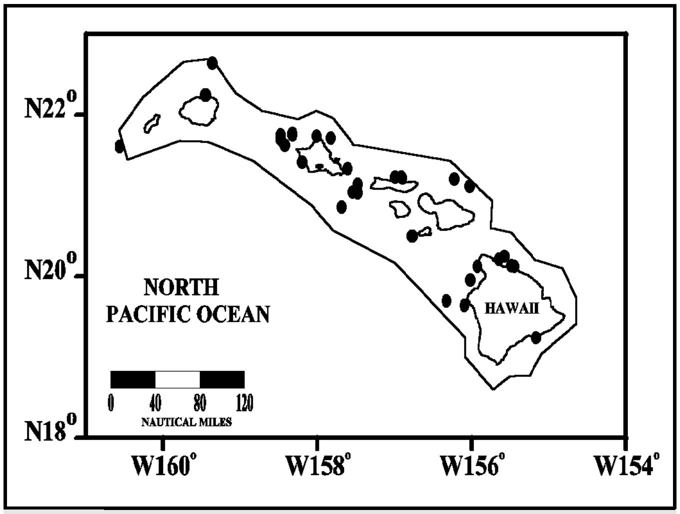

Figure 1. Bottlenose dolphin sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

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 ~~there are no data for a population estimate in Hawaiian waters.~~ it is not known whether these animals are part of the same population that occurs around the Hawaiian Islands. ~~no data are available to make a population estimate in Hawaiian waters.~~ ~~In 1987, a minimum count of 430 bottlenose dolphins was obtained from vessel and aerial surveys of inshore waters around Oahu, Molokai, Lanai, Maui and Hawaii (Naval Ocean Systems Center unpublished data, cited in Nitta and Henderson 1993). It is unclear what proportion of the species' range was surveyed in this study.~~ 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. 1999). 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

~~No data from the past five years are available to make a 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

~~No PBR can be calculated for this species at this time.~~ 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.

~~ANNUAL~~ 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).

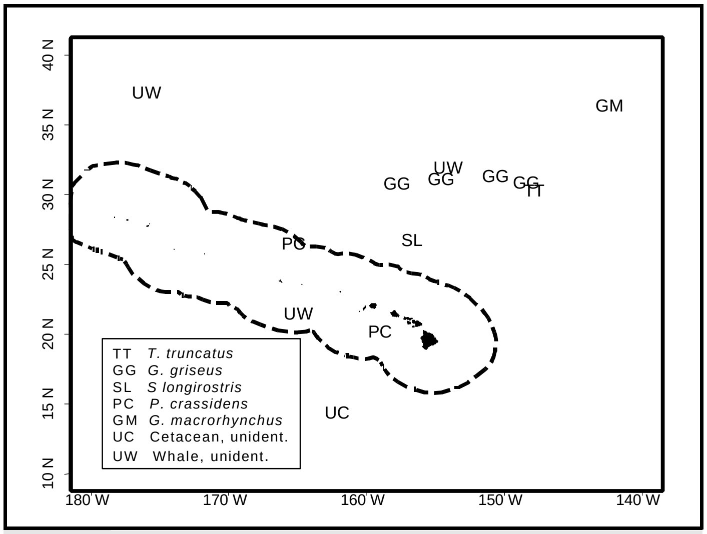

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); TT = bottlenose dolphin.

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.Monofilament small-mesh (about 5cm stretched) gillnets are commonly set on shallow reefs around all the main islands, usually at depths of less than 10 meters (Nitta and Henderson 1993). Inshore reef fish are the targets of this fishing. During 1992/93 the State of Hawaii received 288 applications for fishing permits that listed nets as the primary gear and gillnets were specified in 161 additional applications for permits (Nitta and Henderson 1993).~~

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.

~~They~~ 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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

Other ~~Mortality~~ 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.).

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of bottlenosed dolphins is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~non-~~strategic under the 1994 amendments to the MMPA given the ~~insignificance~~ 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.

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PANTROPICAL SPOTTED DOLPHIN (*Stenella attenuata*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

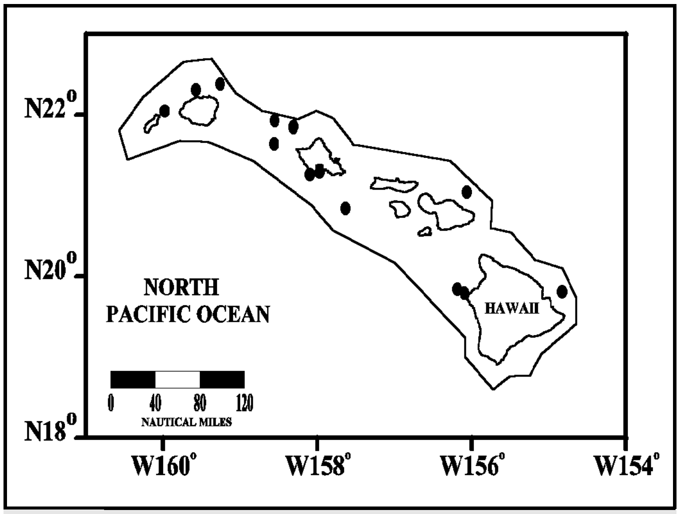

Figure 1. Pantropical spotted dolphin sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

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.

POPULATION SIZE

Population estimates are available for Japanese waters (Miyashita 1993) and the eastern tropical Pacific (Wade and Gerrodette 1993)~~, but no data are available to estimate population size for this species in any part of 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. An abundance estimate of 2,928 (CV=0.45) pantropical spotted dolphins was recently calculated from the combined survey data (Mobley et al. 1999). 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

~~No data are available for a 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

~~No PBR can be calculated for this species at this time.~~ 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

Other ~~Mortality~~ Removals

At least 52 pantropical spotted dolphins were live-captured in Hawaii between 1963 and 1978 (Shallenberger 1981).

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of pantropical spotted dolphins is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. ~~Although information on pantropical spotted dolphins in Hawaiian waters is limited, this stock would be considered non-strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality.~~ 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.

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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. 1999) 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).

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.

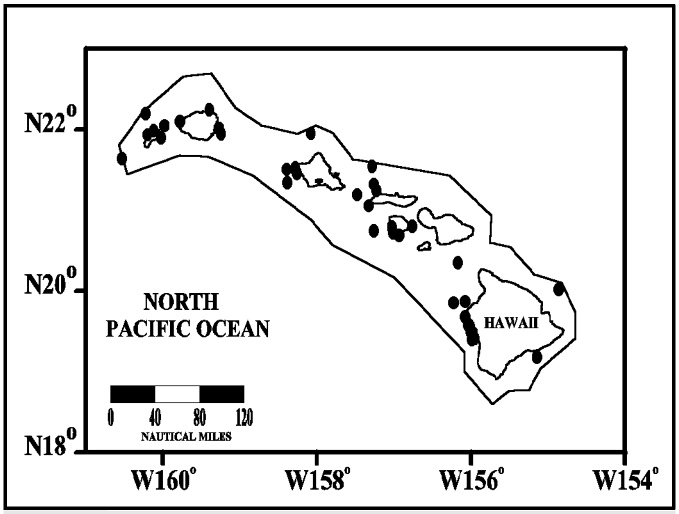

Figure 1. Spinner dolphin sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

~~Wade and Gerrodette (1993) estimated the sizes of populations in the eastern tropical Pacific.~~ 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. 1999). 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 available population estimates apply to only a portion of the species' extensive range in Hawaiian waters. Östman's (1994) total of 677 spinner dolphins can be regarded as a minimum count, but it must be noted that it applies only to the west coast of the island of Hawaii.~~ 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

~~Based on this species' unknown status and growth rate, the recovery factor (F_R) is 0.5 and 1/2 R_{max} is the default value 0.02. Using these values and the minimum count of 677, the PBR is 6.8 animals.~~ 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown. Monofilament small-mesh (about 5cm stretched) gillnets are commonly set on shallow reefs around all the main islands, usually at depths of less than 10 meters (Nitta and Henderson 1993). Inshore reef fish are the targets of this fishing. During 1992/93 the State of Hawaii received 288 applications for fishing permits that listed nets as the primary gear and gillnets were specified in 161 additional applications for permits (Nitta and Henderson 1993).~~

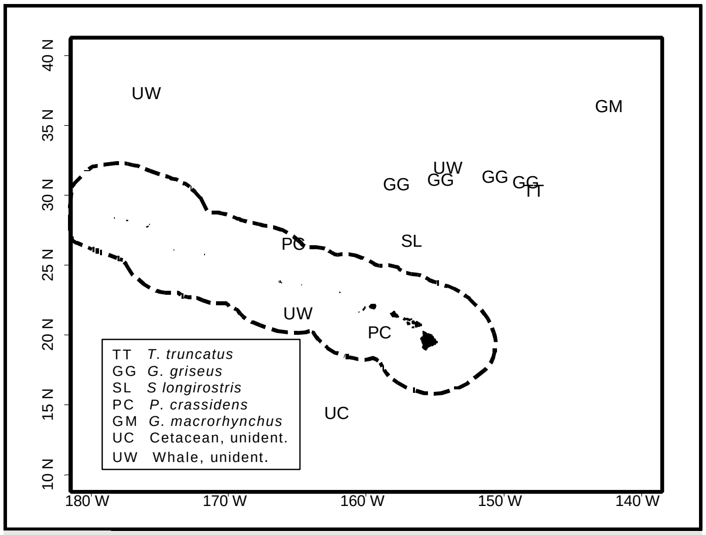

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); SL = spinner dolphin.

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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

Other ~~Mortality~~ 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.

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the total annual mortality of this stock of spinner dolphins is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the Marine Mammal Protection Act have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~would~~ not ~~be~~ considered a strategic stock under the 1994 amendments to the MMPA, ~~because the level of documented take does not exceed the PBR level.~~ 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.

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Revised ~~6/30/95~~ 01/03/00

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).

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.

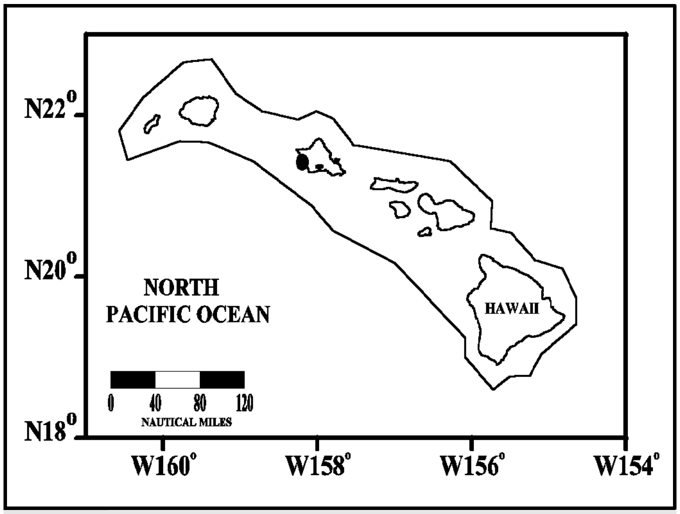

Figure 1. Location of the single sighting of striped dolphins during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Population estimates are available for Japanese waters (Miyashita 1993) and the eastern tropical Pacific (Wade and Gerrodette 1993), but ~~no data are available for a population estimate in Hawaiian waters.~~ 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. 1999). 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

~~No PBR can be calculated for this species at this time.~~ 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of striped dolphins is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown.~~ 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 ~~non-~~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.

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Revised ~~6/30/95~~ 01/03/00

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. 1999) 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.

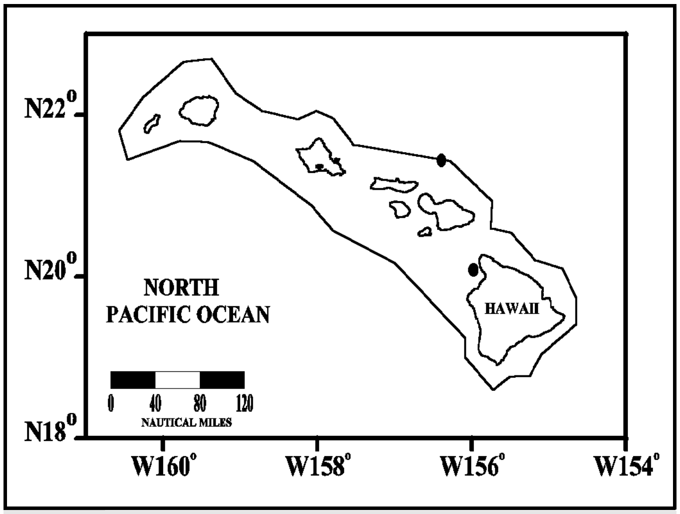

Figure 1. Melon-headed whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

An estimate of melon-headed whales is available for the eastern tropical Pacific (Wade and Gerrodette 1993), but ~~there are no data for population estimates elsewhere~~ it is not known whether any of these animals are part of the same population that occurs around the Hawaiian Islands. ~~In Hawaii, the size of herds is often reported to exceed 500 individuals (Shallenberger 1981). A group of 75-100 animals was consistently observed off the north Kohala coast of Hawaii during the 1970s (Shallenberger 1981).~~ 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. 1999). 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

~~No data are available for a 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

~~It is not possible to calculate a PBR for this stock at this time.~~ 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

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).

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of melon-headed whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public~~

~~and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown.~~ 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 ~~non-~~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.

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Revised ~~6/30/95~~ 01/03/00

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. 1999; 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. 1999). 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have~~

~~been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~ 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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

Other ~~Mortality~~ Removals

Three specimens were live-captured by Sea Life Park between 1963 and 1971 (Pryor et al. 1965; Pryor 1975; Shallenberger 1981).

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of pygmy killer whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown.~~ 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 ~~non-~~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.

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Revised ~~6/30/95~~ 01/03/00

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. 1999) 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.

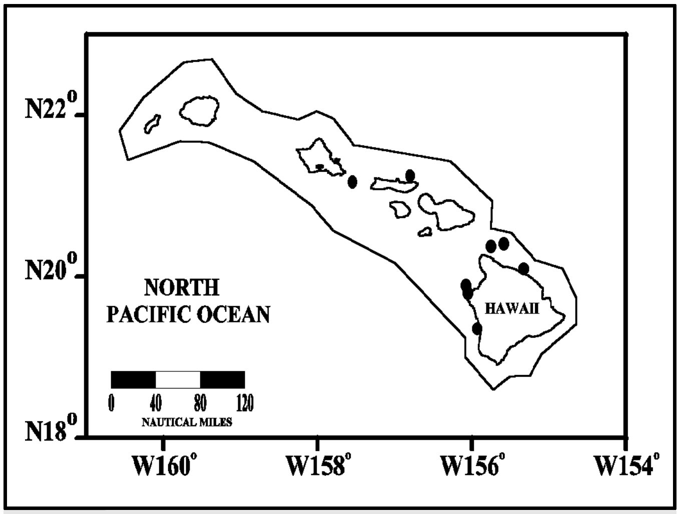

Figure 1. False killer whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

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 ~~there are no estimates for any area of the central Pacific.~~ it is not known whether these animals are part of the same population that occurs around the Hawaiian Islands. ~~A series of aerial surveys was flown in 1989 to obtain a minimum count of false killer whales. These surveys, which only covered portions of the lee shores of Hawaii, Lanai, and Oahu to a maximum distance of 30 nmi offshore, produced a minimum count of 470 false killer whales (Leatherwood and Reeves 1989).~~ 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. 1999). 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.

Minimum Population Estimate

~~No data from the past five years are available to make a 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

~~No PBR can be calculated for this species at this time.~~ 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 0.50 (for a species of unknown status with no known fishery mortality;

Wade and Angliss 1997), resulting in a PBR of 0.8 false killer whales per year.

~~ANNUAL~~ 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 false 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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.).

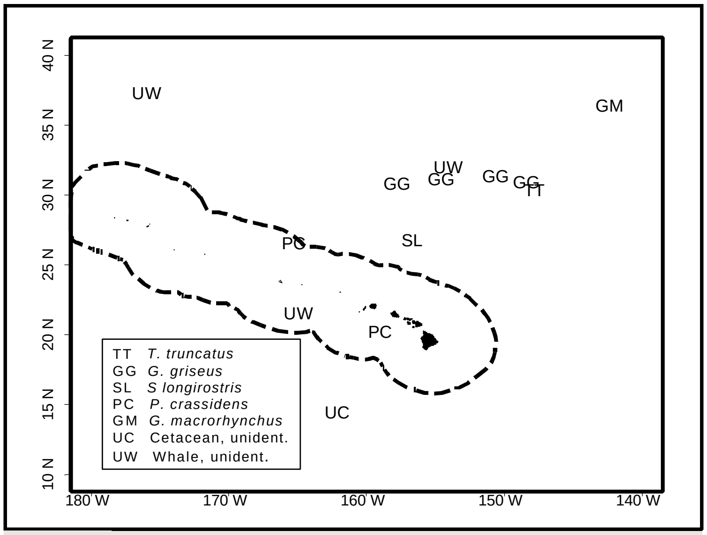

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); PC = false killer whale.

Two false killer whales were observed hooked in the Hawaiian longline fishery between 1994 and 1998 within 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 45 (95% CI = 7-146) false killer whales, or an average of 9 interactions per year (Kleiber 1999). Both of the observed false killer whales were reported to have been hooked in the mouth or to have ingested the hook, and they 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 two observed false killer whales have been considered seriously injured (defined under the MMPA as likely to result in mortality), and, therefore, the interaction rate of 9 animals per year represents an estimate of mortality and serious injury for this stock.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the~~

~~NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

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 ~~Mortality~~ 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.).

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of false killer whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ They are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor as “depleted” under the MMPA. ~~Although information on false killer whales in Hawaiian waters is limited, this stock would be considered non-strategic under the 1994 amendments to the MMPA given the absence of reported fisheries related mortality.~~ Because the rate of serious injury to false killer whales within the U.S. EEZ in the Hawaiian longline fishery (9 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.

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Revised ~~6/30/95~~ 01/03/00

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 ~~Killer whales are found worldwide in tropical to polar 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. 1999; 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", ~~and~~ "transient", and offshore stocks have been described for coastal waters of Alaska, British Columbia, and Washington (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, ~~killer whales within the Pacific U.S. EEZ are divided into four stocks: 1) a Hawaiian stock (this report), 2) a transient stock in Alaska and Washington inland waters, 3) a resident stock in Alaska and Washington inland water, and 4) a California, Oregon and Washington stock.~~ 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. 1999). 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.

~~ANNUAL~~ 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. ~~In 1990, a solitary killer whale was reported to have removed the catch from a longline in Hawaii (Dollar 1991). No other fisheries interactions involving killer whales have been reported.~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

Interactions with cetaceans have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but killer whale interactions appear to be rare.~~, but no interactions with killer whales have been documented.~~ 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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of killer whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown.~~ 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 ~~non-~~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.

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Revised ~~6/30/95~~ 01/03/00

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. 1999) 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.

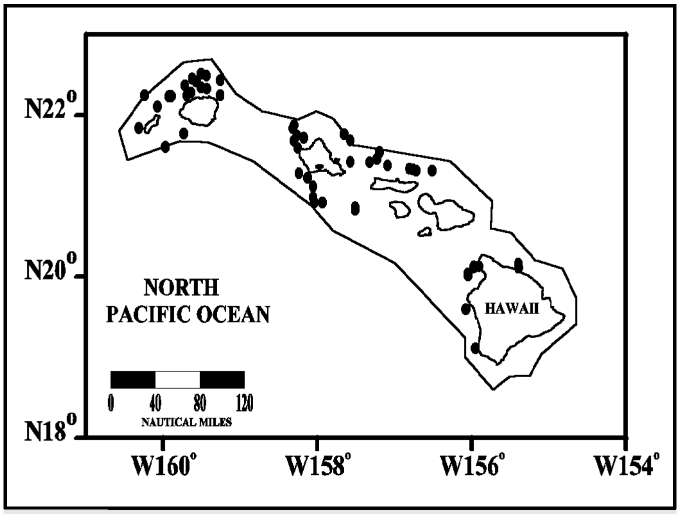

Figure 1. Short-finned pilot whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

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 ~~there are no data to make a population estimate in Hawaiian waters.~~ 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. 1999). 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

~~No minimum population estimate is available.~~ 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

~~No PBR can be calculated for this stock at this time.~~ 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.

~~ANNUAL~~ 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 short-finned pilot whales in Hawaiian waters. However, of other cetacean species~~ 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.

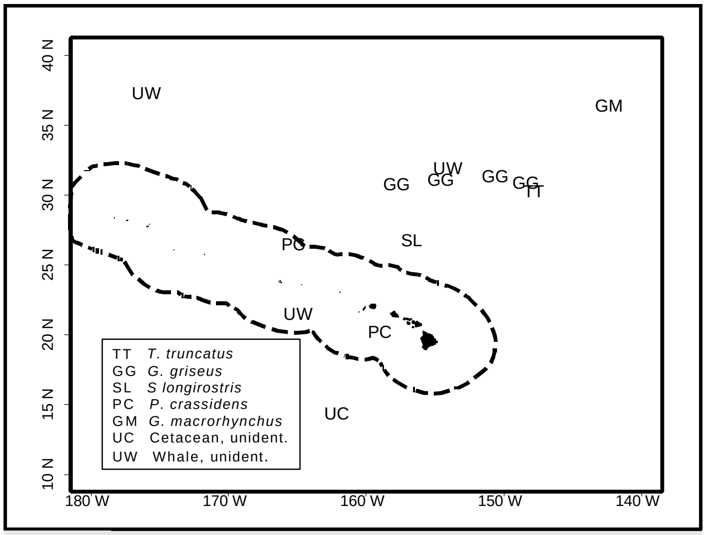

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); GM = short-finned pilot whale.

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

Interactions with cetaceans have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993), but no 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.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands.~~

Other ~~Mortality~~ 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).

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of short-finned pilot whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~non-~~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.

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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. 1999) 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.

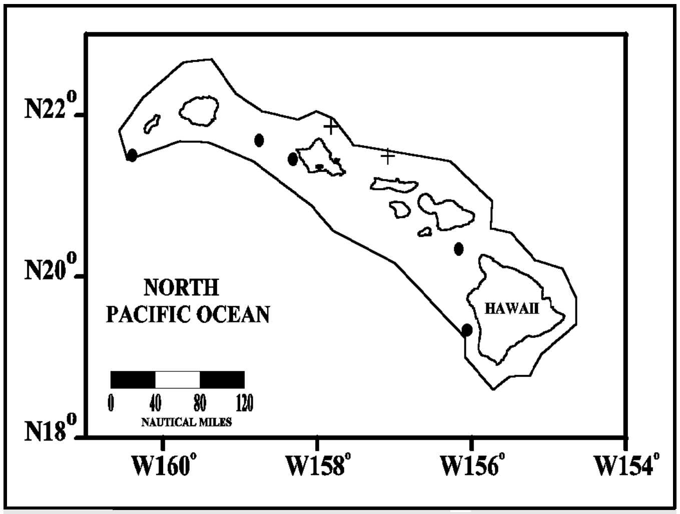

Figure 1. Blainville's beaked whale (●) and unidentified *Mesoplodon* (+) sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

~~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, 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. 1999). 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

~~No data are available for a 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

~~No PBR can be calculated for this species at this time.~~ 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~ 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.

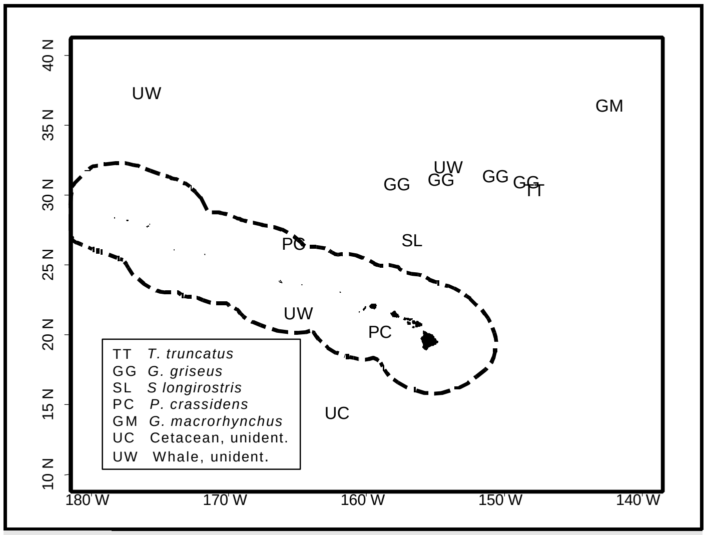

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); UW = unidentified whale; UC = unidentified cetacean. The two westernmost unidentified whales may have been Blainville's beaked whales.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing.~~

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of Blainville's beaked whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~non-~~strategic under the 1994 amendments to the MMPA ~~given the absence of~~ 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”.

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Revised ~~6/30/95~~ 01/03/00

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. 1999) 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.

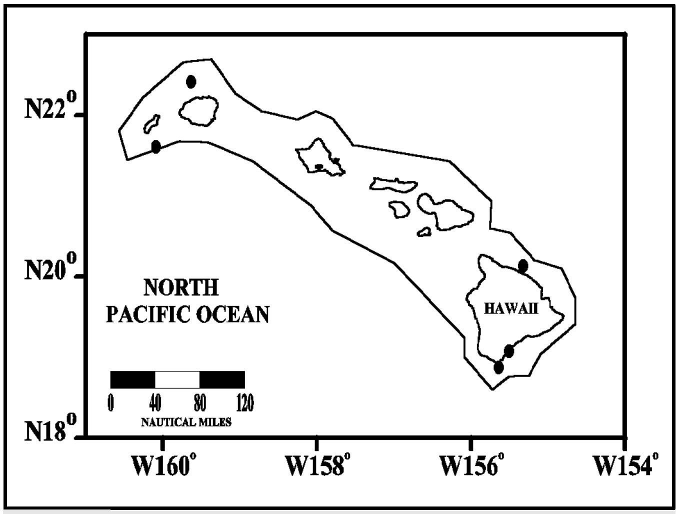

Figure 1. Cuvier's beaked whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Wade and Gerrodette (1993) made an estimate for Cuvier's beaked whales in the eastern tropical Pacific, but ~~no data are available for population estimates elsewhere in the North Pacific.~~ 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. 1999). 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

~~No data are available for a 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

~~No PBR can be calculated for this stock at this time.~~ 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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.

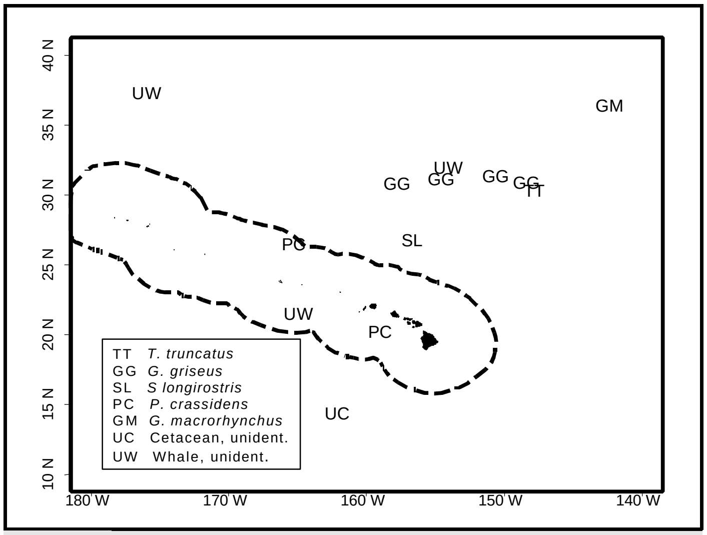

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); UW = unidentified whale; UC = unidentified cetacean. The two westernmost unidentified whales may have been Cuvier's beaked whales.

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing.~~

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of Cuvier's beaked whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~non-~~strategic under the 1994 amendments to the MMPA ~~given the absence of~~ 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".

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Revised ~~6/30/95~~ 01/03/00

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. 1999a). 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.

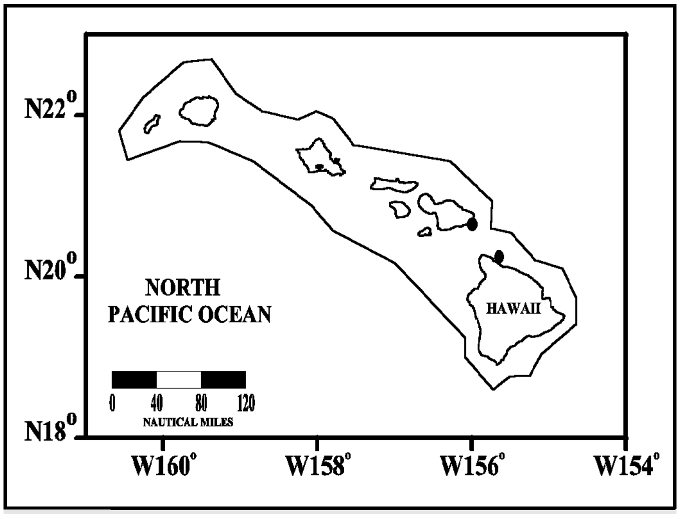

Figure 1. Pygmy or dwarf sperm whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

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. 1999b), 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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).

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing.~~

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of pygmy sperm whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~non-~~strategic under the 1994 amendments to the MMPA ~~given the absence of~~ 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".

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Revised ~~6/30/95~~ 01/03/00

DWARF SPERM WHALE (*Kogia simus*): 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. 1999a). 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, dwarf 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. 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.

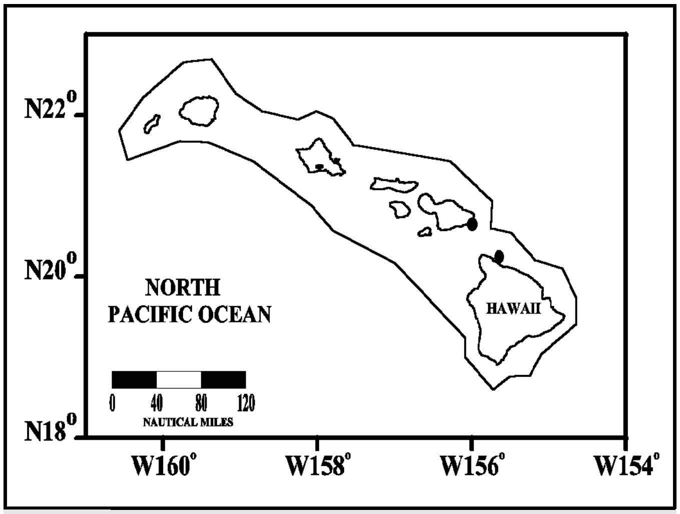

Figure 1. Pygmy or dwarf sperm whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

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. 1999b), 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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).

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing.~~

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of dwarf sperm whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is~~ 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 ~~non-~~strategic under the 1994 amendments to the MMPA ~~given the insignificance of~~ 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".

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Revised ~~6/30/95~~ 01/03/00

SPERM WHALE (*Physeter macrocephalus*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

~~Sperm whales are found in tropical to polar waters throughout the world (Rice 1989).~~ 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, 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 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). 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 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).

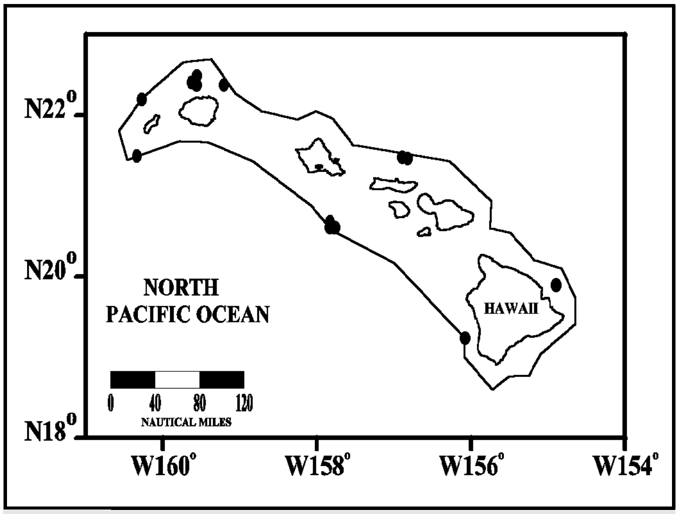

Figure 1. Sperm whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

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

~~Gosho et al. (1984) summarized IWC estimates of "initial" (1910) and "current" (1982) stock sizes for sperm whales in the North Pacific based on a CPUE model. Wade and Gerrodette (1993) estimated 22,700 sperm whales for the eastern tropical Pacific from data collected on ship line-transect surveys. Forney et al. (1995) estimated 892 sperm whales in California waters during winter/spring. However, there are no data available for estimating the number of sperm whales in Hawaiian waters.~~ 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. 1999). 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

~~No data are available to make a 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

~~No PBR can be calculated for this stock at this time.~~ 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 sperm whales per year.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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).

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions~~

~~between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing.~~

Historical Mortality

~~Sperm whales were exploited throughout their range in the North Pacific and equatorial Pacific during the nineteenth century (see Tillman and Donovan 1983). Approximately 268,972 sperm whales were killed by modern whaling operations in the North Pacific from 1910 to 1976 (Ohsumi 1980).~~ 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. ~~Pelagic whaling for sperm whales in the North Pacific ended after the 1979 season (IWC 1981), and coastal whaling for this species ended after the 1988 season (IWC 1989).~~ Some of the whales taken during the whaling era were certainly from a population or populations that occur within Hawaiian waters.

~~**Fishery Mortality Rate**~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of sperm whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the Marine Mammal Protection Act have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. The species is listed as endangered under the U.S. Endangered Species Act (1973); therefore, the Hawaiian stock is classified as a strategic stock according to the 1994 amendments to the MMPA.~~ 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".

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BLUE WHALE (*Balaenoptera musculus*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Blue whales are ~~found in tropical to polar waters throughout the world~~ extremely rare in Hawaii. The only published sighting record is that of Berzin and Rovnin (1966) north of the Hawaiian Islands . ~~No sightings or strandings of blue whales have been reported in Hawaii.~~ ~~The only~~ 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 ~~almost certainly~~ 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° 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. ~~Also from ship line-transect surveys, Barlow (1995) estimated 2,250 blue whales in the California/Mexico stock.~~ A weighted average estimates 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. 1999).

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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing.~~

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.

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of blue whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The status of this stock relative to OSP under the MMPA is also unknown. The species~~

~~is listed as endangered under the Endangered Species Act (1973); therefore, the Hawaiian stock is classified as a strategic stock according to the 1994 amendments to the MMPA.~~ 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).

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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). ~~There have been only two confirmed sightings off Oahu and a~~ 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 stock structure of fin whales in the North Pacific is uncertain (Mizroch et al. 1984).~~ 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. 1999). 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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).

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing.~~

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.

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of fin whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA have been reviewed by the public and finalized.~~

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. ~~The stock's status relative to OSP under the MMPA is also unknown. This species is listed as endangered under the Endangered Species Act (1973); therefore, the Hawaiian stock is classified as a strategic stock under the 1994 amendments to the MMPA.~~ 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.

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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. 1999). 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.

~~ANNUAL~~ 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).

~~Pelagic, bottomfish and lobster fisheries occur in Hawaiian waters. Pelagic fisheries include commercial fisheries (troll, handline, longline, local inshore gillnet), commercial charter and recreational troll fishing. Only the longline fishery is subject to active management through a Fishery Management Plan. The growth of the longline fleet between 1989 and 1991 generated concerns regarding impact on fish stocks (especially swordfish), on other fisheries (troll, handline), and on protected species (mainly sea turtles). The value of longline landings increased to almost $45 million in 1992 and 1993. Regulations established longline fishery permit and reporting requirements, area closures in the Northwestern Hawaiian Islands (NWHI) to protect Hawaiian monk seals and in the main Hawaiian Islands to prevent gear conflicts, a limited entry program, a mandatory observer program, and a requirement for installation and operation of vessel monitoring equipment on longline vessels in Hawaii. Approximately 165 longline permits have~~

~~been issued. The commercial non-longline fisheries (troll, handline, gillnet) have more than 2,000 participants but account only for about $10 - $15 million per year in landings. The number of anglers and value of recreational fishing are unknown.~~

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).

~~The commercial lobster fishery in the NWHI is managed by federal regulations which include size limits, area closures, seasons, gear restrictions, annual quotas and reporting requirements. Fifteen permits have been issued for this fishery. The fishery was closed in 1993 and only five vessels operated in the fishery in 1994. No interactions between marine mammals and this fishery have been recorded in the past five years.~~

~~The bottomfish fishery occurs throughout the NWHI and the main Hawaiian Islands using handlines. In the NWHI, there are two zones in which fishing takes place. The Ho'omalu Zone has limited entry and the Mau Zone has open access. There are currently 11 permits for the Ho'omalu Zone and 30 for the Mau Zone. However, in 1994, only five vessels fished in the Ho'omalu Zone and 15-20 vessels fished in the Mau Zone. Total landings of bottomfish in Hawaii from all waters have fluctuated little in recent years, about 400,000 pounds per year from the NWHI and about 500,000 pounds per year from the main Hawaiian Islands. Fishermen claim interactions with dolphins who steal bait and catch are increasing.~~

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).

~~Fishery Mortality Rate~~

~~The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero because the population size of this stock of Bryde's whales is unknown. Determination cannot be made for individual fisheries until the implementing regulations for section 118 of the MMPA (MMPA) have been reviewed by the public and finalized.~~

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. ~~This species is not listed as threatened or endangered under the Endangered Species Act (1973). The status of this stock relative to OSP under the MMPA is unknown.~~ 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 ~~non-~~strategic under the 1994 amendments to the MMPA ~~given the absence of~~ 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.

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Revised 01/03/00

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 5-8 describe the same features for the California angel shark/halibut set 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. ~~Figures 9-10 show trends of effor and observer coverage these two fisheries and Figure 11 shows the statistical reporting areas for fisheries in the State of Washington.~~

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 ~~this~~ these observer programs ~~is~~ are combined with estimates of total effort ~~in the CA swordfish drift gill net fishery,~~ 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). ~~This reporting requirement was implemented in April 1996. In 1996, 39 reports were received by fishers participating in the swordfish drift gillnet and 7 reports from fishers participating in the halibut set gillnet fishery. Mortalities and injuries reported in 1996 are compared with NMFS Observer Program data in the following table.~~

3. NMFS Marine Mammal Stranding Network data

~~A total of 1,538 marine mammal strandings was reported to the California MMSN in 1996: 89 cetaceans and 1,449 pinnipeds (Table 2). Cetacean strandings of interest included 2 pygmy sperm whales, 1 Cuvier's beaked whale, and 1 unidentified beaked whale. Pinniped strandings of interest included 10 northern sea lions, 12 northern fur seals, and 2 Guadalupe fur seals.~~ 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. ~~A few incidents of gray whale entanglement were attributed to set net fishery entanglement and to trap fishery entanglement.~~

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 ~~is 172 for the 1996/97 fishing season~~ 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. ~~There were 10 developmental fishery permits issued by the state of Oregon in 1996 and an additional 6 permits for 5 single deliveries each.~~

Number of active permit holders: The number of vessels actively fishing during 1995 ~~was 130~~ and 1997-1998 was 130, 115 and 123 (3 from Oregon) respectively. The number of permit holders observed by NMFS ~~observers during 1995 was 51~~ from 1994-1998 were 70, 52, 51, 74 and 67 respectively.[1]

Total effort: ~~Estimated total effort for the drift-net fishery during calendar year 1995 is 3,673.~~ 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.) ~~The number of observed effort-days during 1995 was 572 (in 97 trips).~~ There were 636 (113 trips) of observed effort-days in 1998.

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[1] Pers. Comm. Robert Read California Dept. of Fish and Game.

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). ~~In recent years, the state of Oregon has released permits for a limited number of drift-net landings.~~ Figures 1-5 show locations of observed sets ~~during the NMFS Observer Program, 7/90 - 1/96 and during 1995, respectively. Approximate locations of observed marine mammal entanglements are shown in Figures 3-4 for these time periods~~ 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 ~~no such restriction~~ 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 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. ~~The depth of water ranges from 250-2,250 fathoms.~~

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 ~~is currently monitored by NMFS observers. Effort in this fishery ranged around 10,000 sets/year from 1983 through 1987 and then declined to about 5,000 sets/year in the early 90s. Effort is now about 4,000 sets/year.~~ 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]. ~~Mortalities and injuries reported to the MMAP are compared with observed data reported from the NMFS Observer Program in Table 1.~~

Category I, CA angel shark/halibut large mesh (>8.0 in) set gillnet fishery.

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[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.

[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.

Appendix 1. Fishery Descriptions

Number of permit holders: ~~The number of legal permit holders in this fishery is approximately 80~~. 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. ~~is 258 for the 1998/9 fishing season~~.

Number of active permit holders: ~~Approximately 60~~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. ~~During 1998,~~ 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 ~~Estimated total effort for this fishery during calendar year 1995 was 2,257~~ effort-days ~~(1,943 in 1994)~~ 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). ~~The observed effort during 1994 was 151 days with 547 sets.~~ ~~This fishery is not currently observed and has not been observed since July 1994.~~ Figures 11-15 show estimated effort for the years 1994-1998. ~~during 7/90-7/94, and 1/94-7/94~~ ~~are shown in Figures 11-15. respectively.~~ ~~Approximate location of marine mammal entanglements for the same periods are shown in Figures 16-20~~. 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 ~~1995~~ 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].

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. ~~Figures 5-6 show the approximate location of observed sets during the period 7/90 - 12/94 and during 1994, respectively. Figures 7-8 show the approximate locations of marine mammal entanglements during these same time periods.~~ 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. ~~(principally the north portion)~~.

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[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 Mateo County to a line extending 220° 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 180° true from Point Fermin and a line running 270° true from the south jetty of Newport Harbor." [CA Fish & Game Code section 8610.2(d)(3)].

Appendix 1. Fishery Descriptions

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 near PBR. ~~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.~~Approximate location of marine mammal entanglements for the same periods are shown in Figures 16-20~~

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 ~~Overall, the current~~ number of legal permit holders in the category gill/trammel nets. ~~excluding swordfish drift gillnets and herring gillnets, is 258. This type of permit is called a general gill or trammel net permit.~~

Number of active permit holders:. ~~Approximately 60 based on the number of vessels actively fishing in the halibut/angel-shark fishery.[2]~~ 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 ~~was~~ an estimated ~~at~~ 261, 276, 411 and 761 days of effort. ~~(a decrease of 65 days from effort in 1994).~~ ~~This fishery is not currently observed.~~ 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.

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[6] Pers. Comm. Mary Larson, CDFG biologist.

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 ~~the National Marine Fisheries Service and the California Department of Fish and Game~~ 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.

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[7] Descriptions of Washington and Oregon fisheries provided by the Northwest Region, NMFS.

Geographic Range: The fishery occurs in the inland marine waters south of the U.S./Canada border and east of the 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

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.

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[8] Pers. Comm. Diana Watters, biologist at CDFG Menlo Park.

[9] This fishery description was provided by Marija Vojkovich, biologist at CDFG Santa Barbara.

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 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. BOTH REGULATIONS HAVE NOT YET BEEN IMPLEMENTED.

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.

Appendix 1. Fishery Descriptions

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.

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, 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 40°30' 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.

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[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.

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.

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 ~~In 1998 there were~~ 164 permits under a (1994) federal ~~holders. A~~ limited entry program ~~for this fishery is in place~~.

Number of active permit holders: In 1998 there were 114 active fishing vessels. For the years 199~~4~~1-1997 the average number of active fishing vessels was 118 vessels, declining from the peak ~~approximately 125, 110, 103 and 105 respectively. This number peaked~~ in 1991 ~~with~~ 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 ~~EEZ and the main~~ Hawaiian Islands' ~~(MHI)~~ EEZ with less effort in the EEZ's of ~~Northwestern Hawaiian Islands (NWHI) or other~~ 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 ~~in the central Pacific region (approximately 1,000 mi.~~ north of ~~the~~ Hawaii, (as much as 2,000 miles from Honolulu) ~~an Islands)~~, 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), ~~each~~ 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).

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[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.

Regulations: Effort is required to be outside of 50 nautical miles from the entire Northwestern Hawaiian islands (NWHI) ~~chain~~ 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 ~~typically bycatch~~ caught incidentally. A small number of ~~M~~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 ~~were~~ have been reported. Due to interactions with protected species, especially turtles, this 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 ~~NWHI and~~ 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 ~~a~~ 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. ~~However, since~~ In 1996, the fishery ~~has~~ bec~~o~~ame "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.

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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.

Regulations: Season, gear and quota restrictions (see above) for the NWHI were formulated by the Western Pacific Regional Fishery Management Council ~~sets policy which is~~ and implemented by NMFS.
~~There are season, gear and quota restrictions (see above).~~ 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 ~~green spiny lobster and~~ ridgeback slipper lobster ~~are~~ is also taken. Protected species of concern include monk seals (mentioned above) and turtles. ~~However, since 1995~~ There have been no ~~direct~~ interactions with these species since 1995 but they have been seen in the vicinity of the fishing gear. ~~This fishery has had a turbulent recent history. In 1993, pre-season quota estimates were below zero (in part due to fishing pressure) resulting in a complete closure of the fishery. In 1994, in-season reports of low commercial catch rates prompted a mid-season closure. In 1995, the fishery opened to only one vessel and a comprehensive review of the quota setting procedure was undertaken by the Western Pacific Regional Fishery Management Council. More normal fishing seasons resumed in 1996.~~

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 NWHI fishery is restricted to a maximum of 17 vessels, whereas~~ tThe 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 199~~7~~8 in the MHI approximately 8,500 trips were made with a total catch of 424,000 pounds ~~and sold 364,315 pounds~~ for an ex-vessel landing value of ~~$1,588,812~~$1,336,000. This fishery occurs primarily in offshore banks and pinnacles. In the NWHI ~~346,000~~ 332,000 pounds ($894,000) were caught in 199~~7~~8, ~~a little~~ 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 ~~are~~ 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 conentrated 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 ~~in the MHI~~.

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		

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

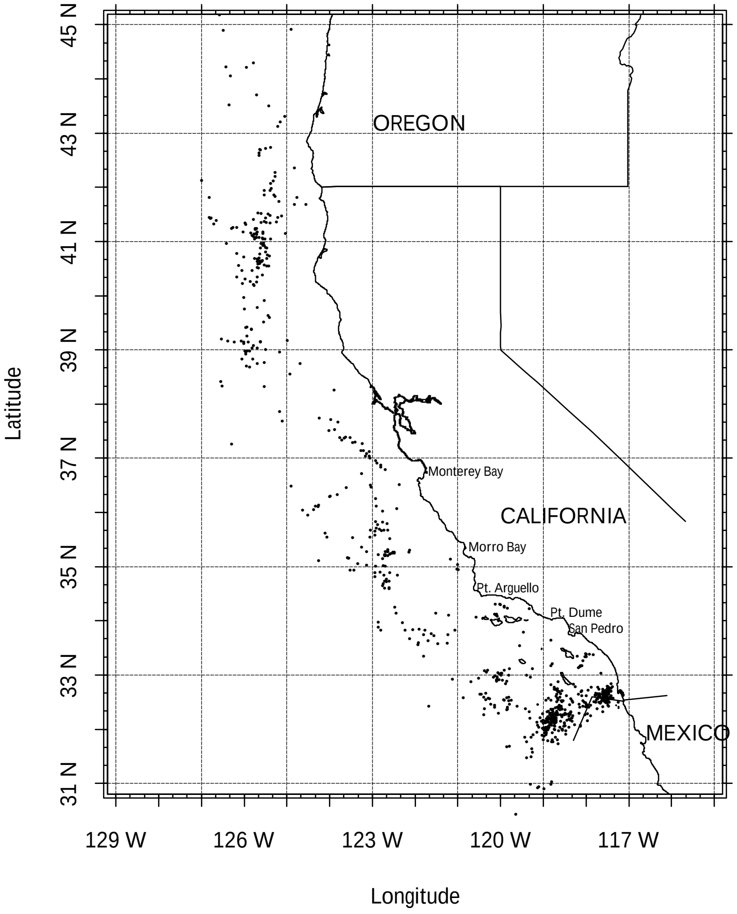

45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
129 W
126 W
123 W
120 W
117 W
Longitude
OREGON
CALIFORNIA
MEXICO
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro

Figure 1. Observed set locations of the drift-net fishery during 1994.

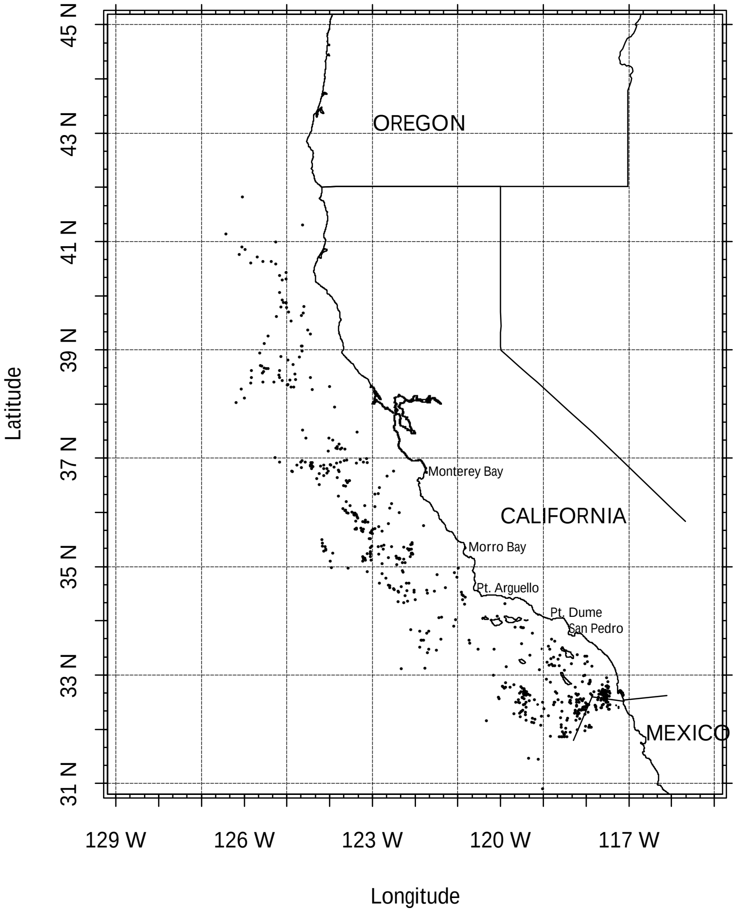
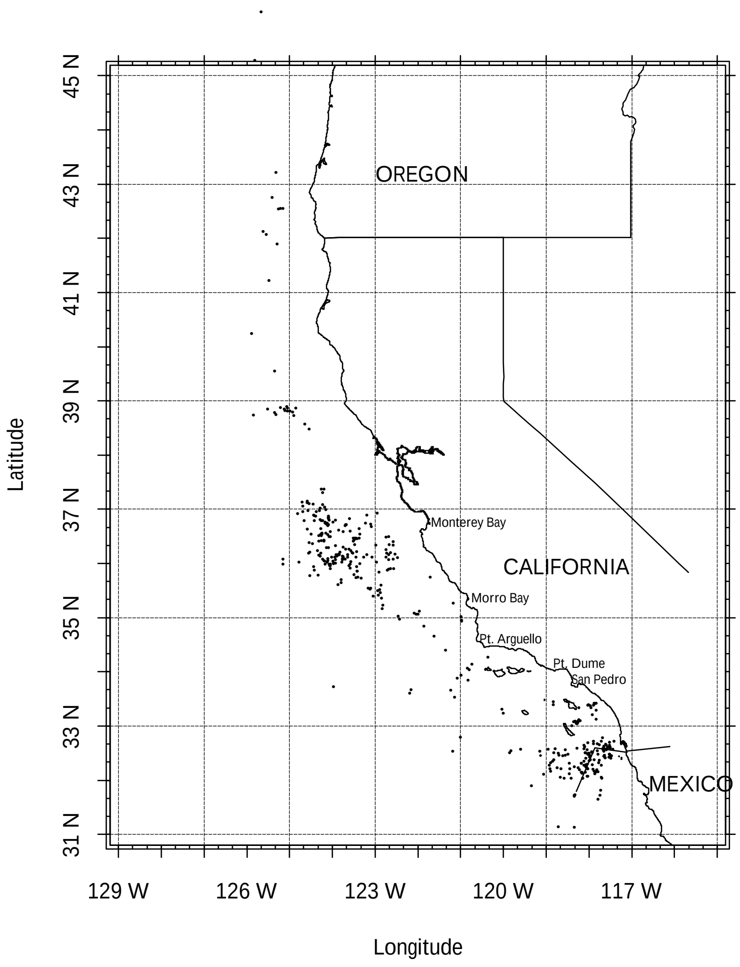

45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
129 W
126 W
123 W
120 W
117 W
Longitude
OREGON
CALIFORNIA
MEXICO
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro

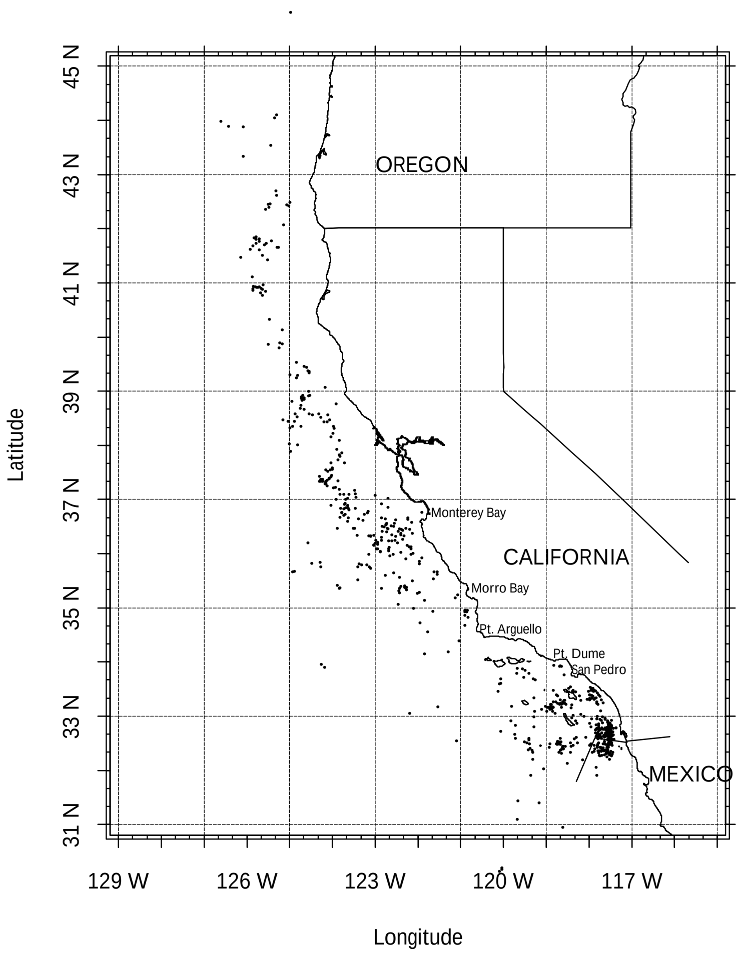
Figure 2. Observed set locations of the drift-net fishery during 1995

Appendix 1. Fishery Descriptions



45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
OREGON
CALIFORNIA
MEXICO
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
129 W
126 W
123 W
120 W
117 W
Longitude

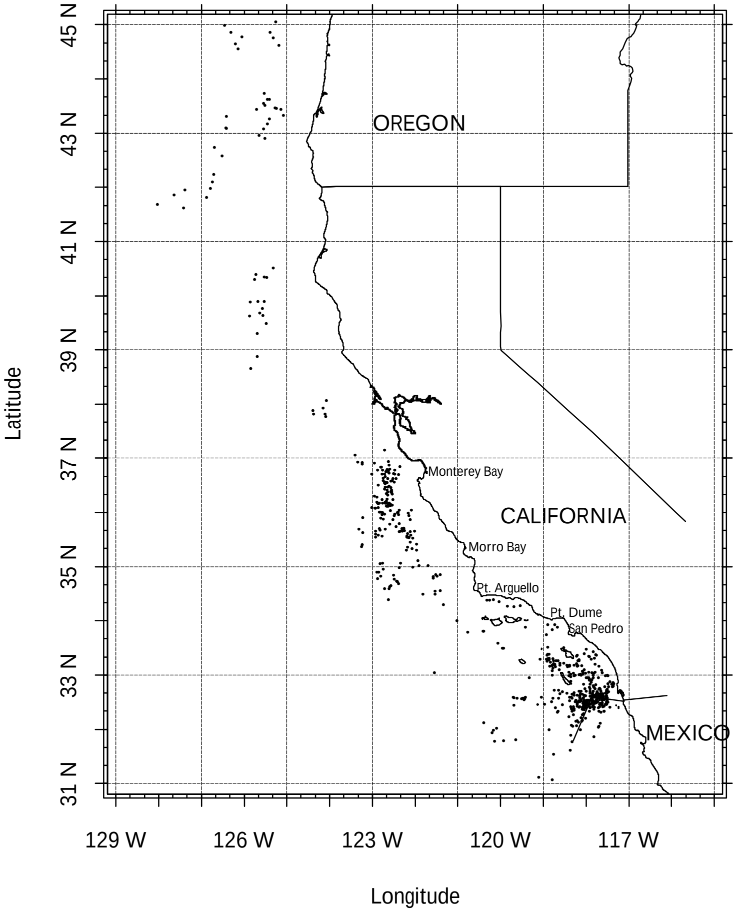
Figure 3. Observed set locations of the drift-net fishery during 1996.



45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
OREGON
CALIFORNIA
MEXICO
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
129 W
126 W
123 W
120 W
117 W
Longitude

Figure 4. Observed set locations of the drift-net fishery during 1997.

Appendix 1. Fishery Descriptions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43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
OREGON
CALIFORNIA
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
MEXICO
129 W
126 W
123 W
120 W
117 W
Longitude

Figure 5. Observed set locations of the drift-net fishery during 1998.

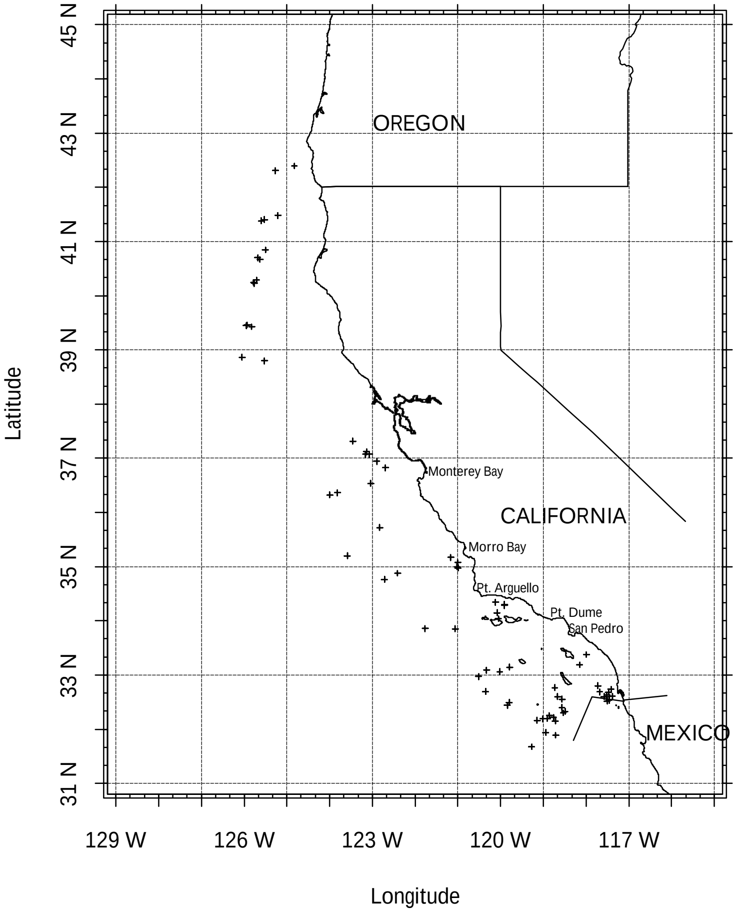

45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
OREGON
CALIFORNIA
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
MEXICO
129 W
126 W
123 W
120 W
117 W
Longitude

Figure 6. Observed locations of marine mammal entanglements of the drift-net fishery during 1994.

Appendix 1. Fishery Descriptions

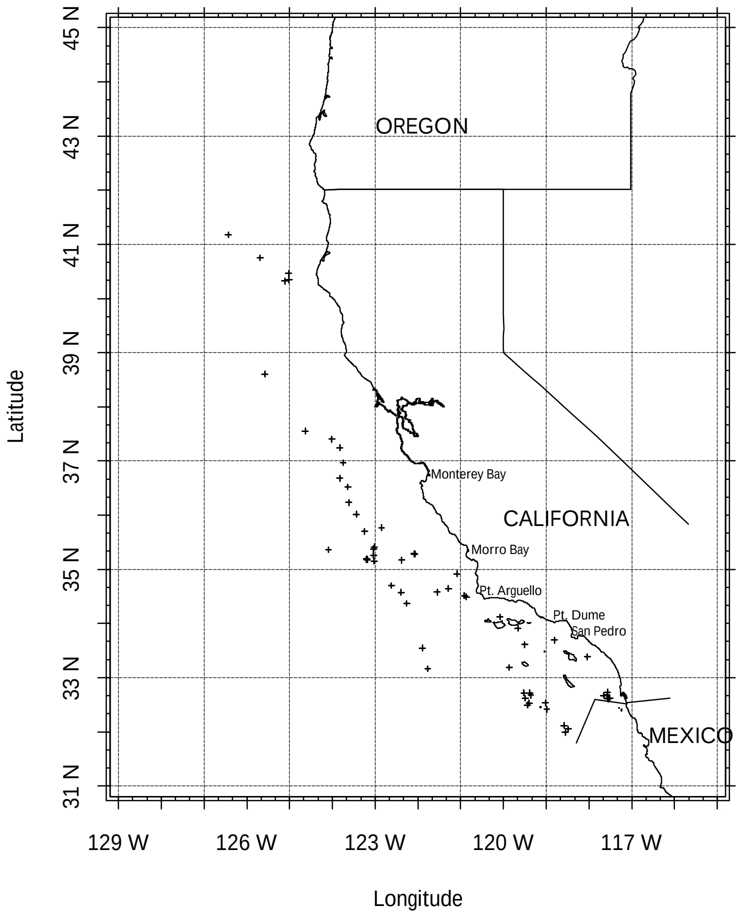

45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
129 W
126 W
123 W
120 W
117 W
Longitude
OREGON
CALIFORNIA
MEXICO
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro

Figure 7. Observed locations of marine mammal entanglements of the drift-net fishery during 1995.

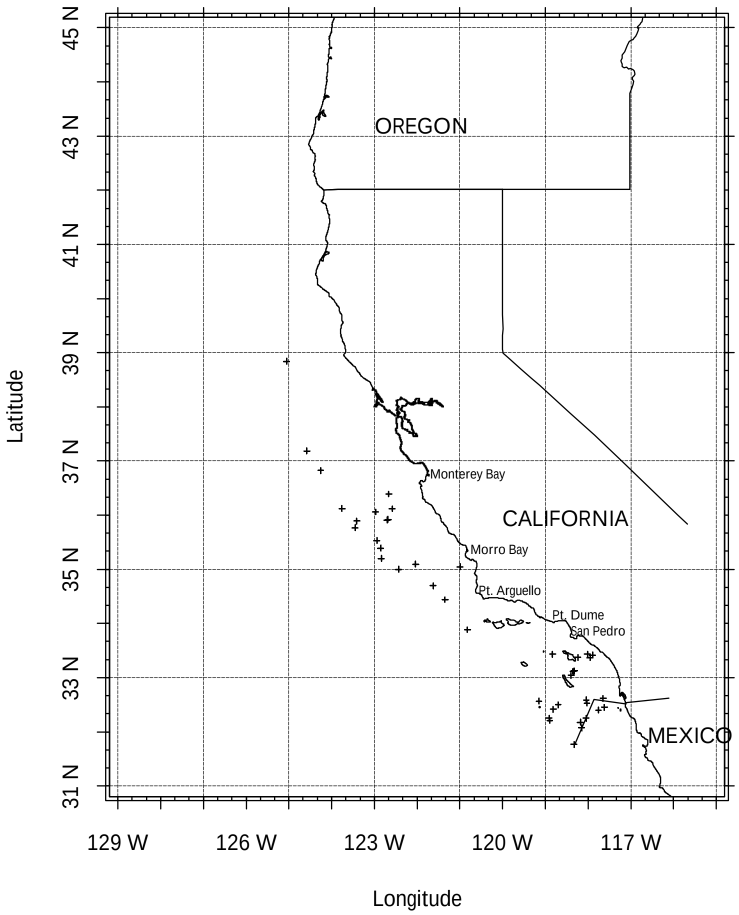

45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
129 W
126 W
123 W
120 W
117 W
Longitude
OREGON
CALIFORNIA
MEXICO
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro

Figure 8. Observed locations of marine mammal entanglements of the drift-net fishery during 1996.

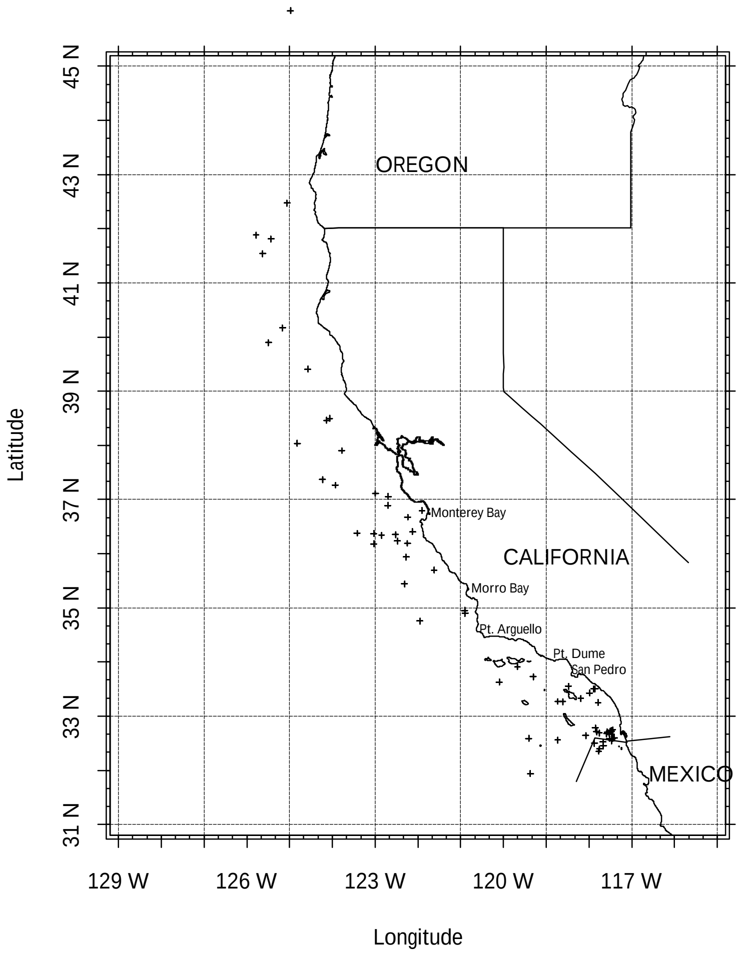

45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
OREGON
CALIFORNIA
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
MEXICO
129 W
126 W
123 W
120 W
117 W
Longitude

Figure 9. Observed locations of marine mammal entanglements of the drift-net fishery during 1997.

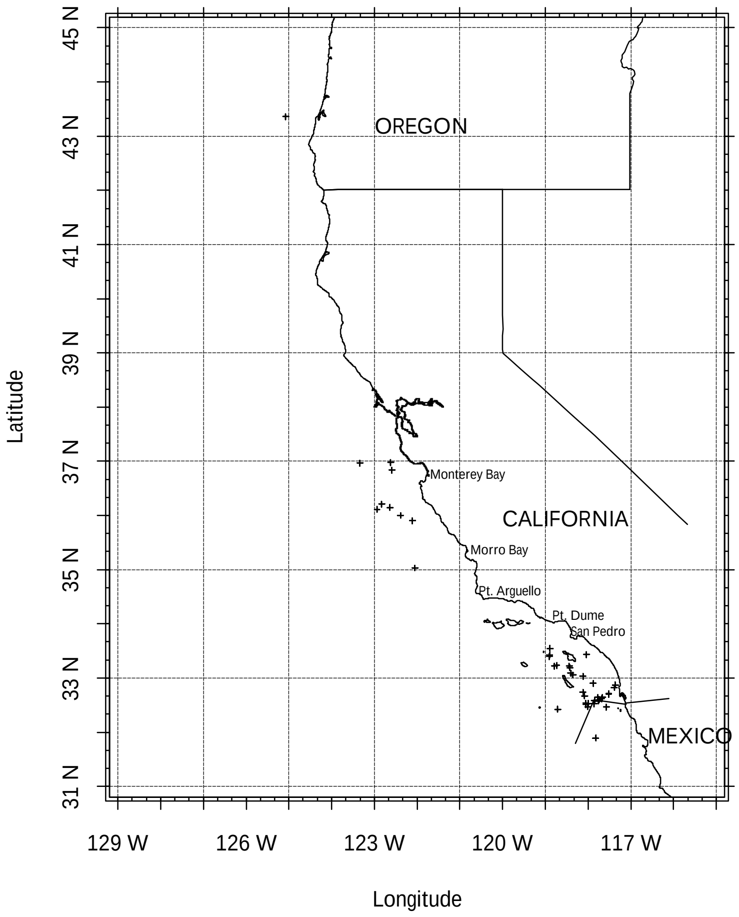

45 N
43 N
41 N
39 N
37 N
35 N
33 N
31 N
Latitude
OREGON
CALIFORNIA
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
MEXICO
129 W
126 W
123 W
120 W
117 W
Longitude

Figure 10. Observed locations of marine mamal entanglements of the drift-net fishery during 1998.

Appendix 1. Fishery Descriptions

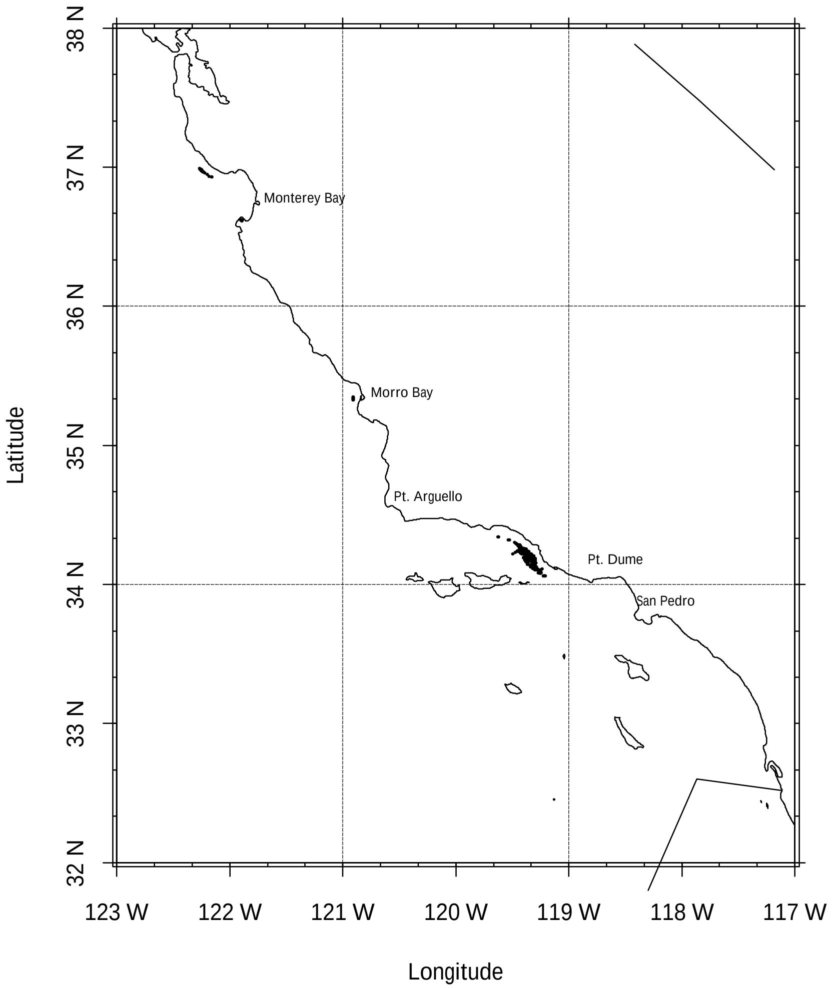

Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
Latitude
38 N
37 N
36 N
35 N
34 N
33 N
32 N
123 W
122 W
121 W
120 W
119 W
118 W
117 W
Longitude

Figure 11. Observed set locations of the set gillnet fishery during 1994.

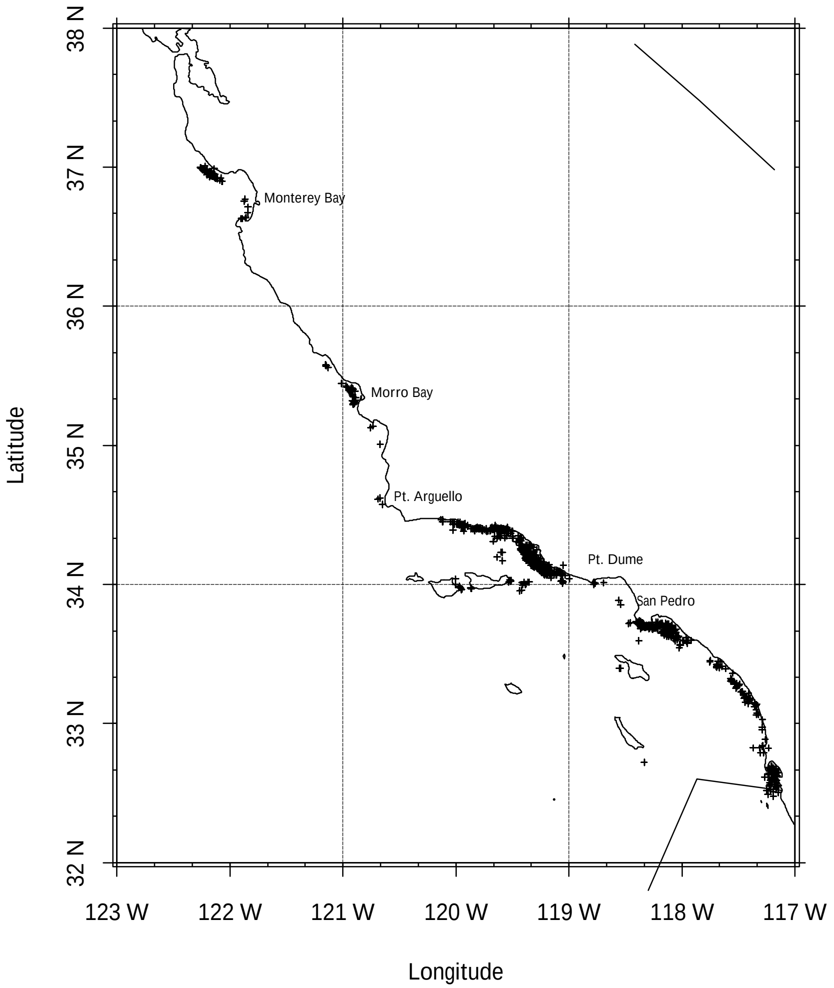
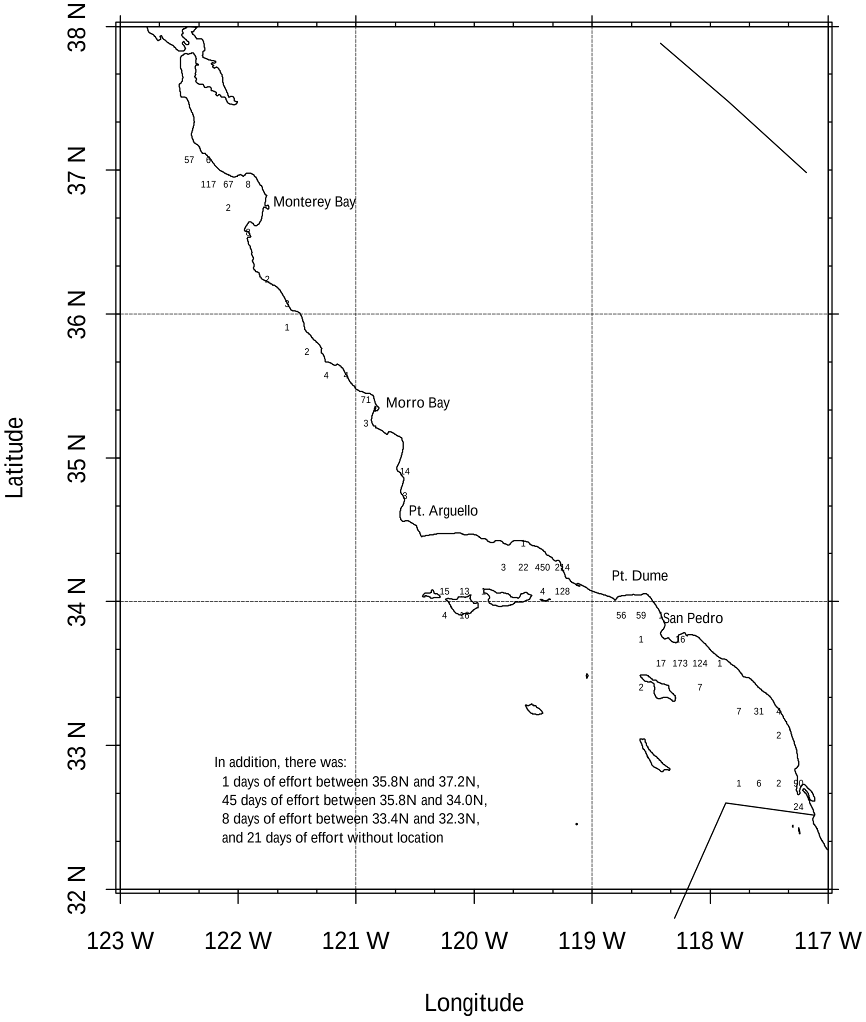

Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
Latitude
38 N
37 N
36 N
35 N
34 N
33 N
32 N
123 W
122 W
121 W
120 W
119 W
118 W
117 W
Longitude

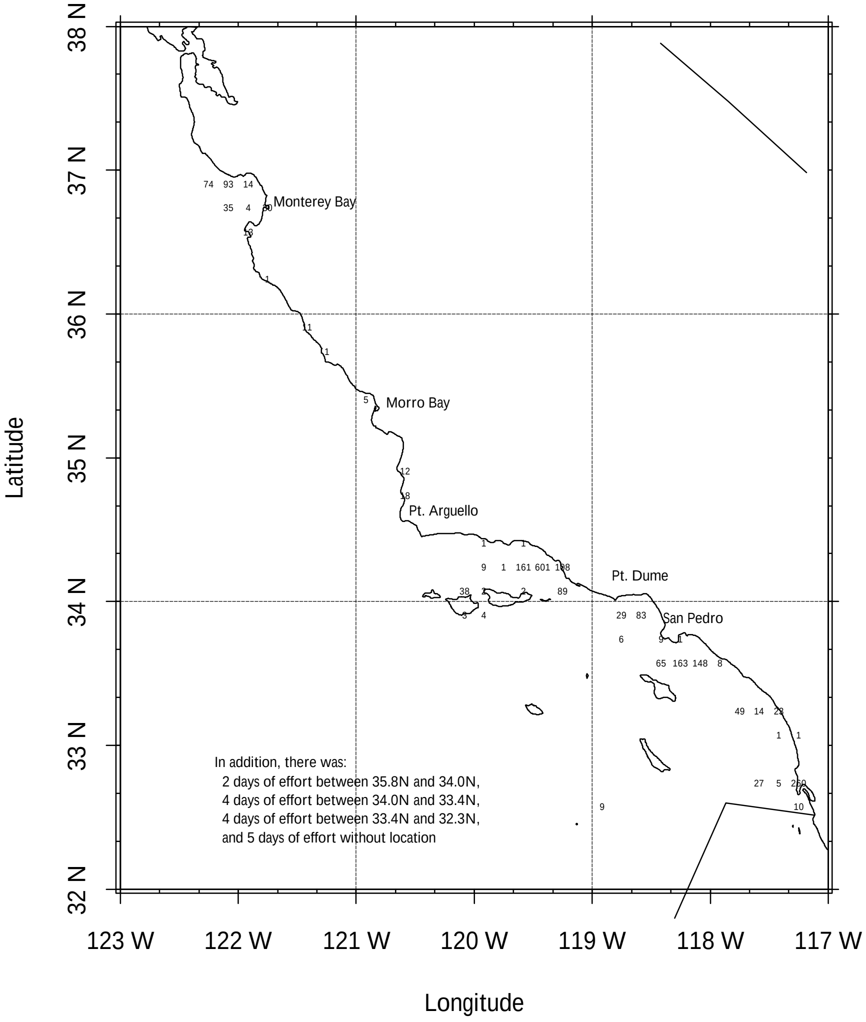
Figure 12. Observed marine mammal entanglements of the set gillnet fishery, 1990-1994.

Appendix 1. Fishery Descriptions


38 N
37 N
36 N
35 N
34 N
33 N
32 N
Latitude
123 W
122 W
121 W
120 W
119 W
118 W
117 W
Longitude
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
57
6
117
67
8
2
3
2
3
1
2
4
4
71
3
14
3
1
3
22
450
214
15
13
1
4
128
4
16
56
59
1
1
16
17
173
124
1
2
7
7
31
4
2
1
6
2
90
24

In addition, there was:
1 days of effort between 35.8N and 37.2N,
45 days of effort between 35.8N and 34.0N,
8 days of effort between 33.4N and 32.3N,
and 21 days of effort without location

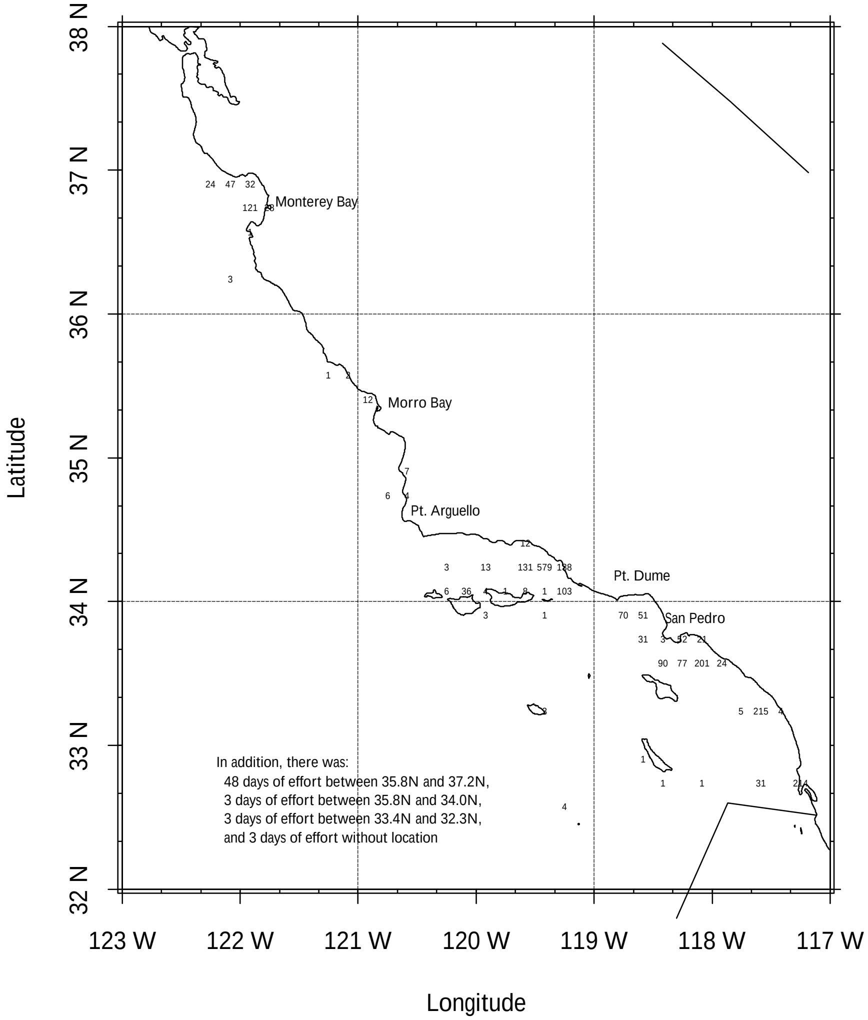
Figure 13. Set gillnet fishery estimated days of fishing effort by CDFG block for 1994.


38 N
37 N
36 N
35 N
34 N
33 N
32 N
Latitude
123 W
122 W
121 W
120 W
119 W
118 W
117 W
Longitude
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
74
93
14
35
4
30
13
1
11
1
5
12
18
1
1
9
1
161
601
108
38
2
2
89
3
4
29
83
6
9
1
65
163
148
8
49
14
23
1
1
27
5
260
10
9

In addition, there was:
2 days of effort between 35.8N and 34.0N,
4 days of effort between 34.0N and 33.4N,
4 days of effort between 33.4N and 32.3N,
and 5 days of effort without location

Figure 14. Set gillnet fishery estimated days of fishing effort by CDFG block for 1995.

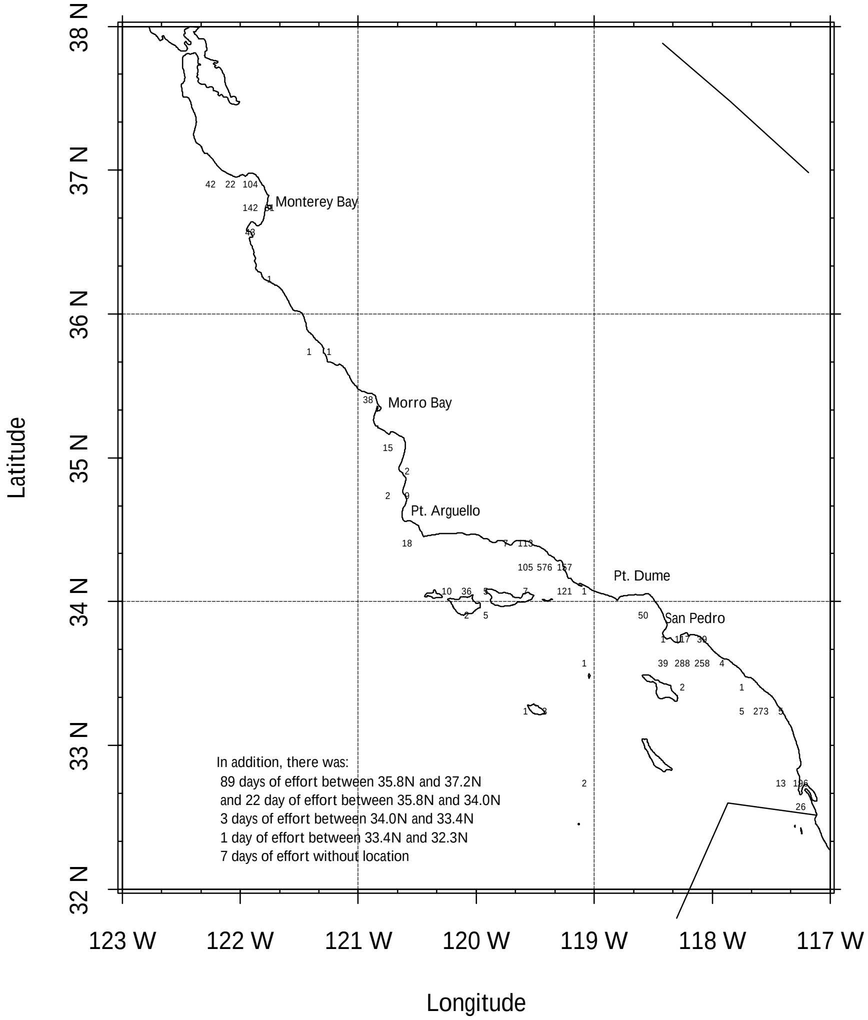
Appendix 1. Fishery Descriptions



38 N
37 N
36 N
35 N
34 N
33 N
32 N
Latitude
24 47 32
121 28
Monterey Bay
1
3
1 2
12
Morro Bay
7
6 4
Pt. Arguello
12
3 13 131 579 138
6 36 4 1 8 1 103
3 1
Pt. Dume
70 51
San Pedro
31 3 52 21
90 77 201 24
3
5 215 4
1
1 1 31 214
4
123 W
122 W
121 W
120 W
119 W
118 W
117 W
Longitude

In addition, there was:
48 days of effort between 35.8N and 37.2N,
3 days of effort between 35.8N and 34.0N,
3 days of effort between 33.4N and 32.3N,
and 3 days of effort without location

Figure 15. Set gillnet fishery estimated days of fishing effort by CDFG block for 1996.

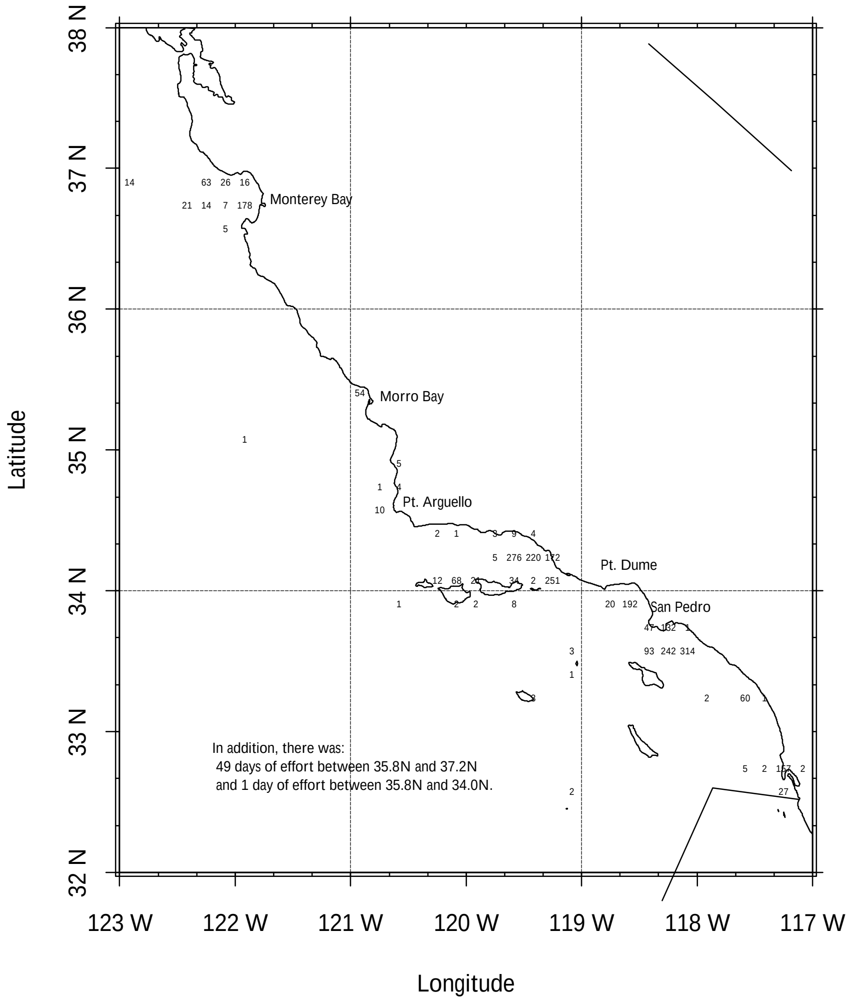


38 N
37 N
36 N
35 N
34 N
33 N
32 N
Latitude
42 22 104
142 61
Monterey Bay
43
1
1 1
38
Morro Bay
15
2
2 9
Pt. Arguello
18
7 113
105 576 157
10 36 5 7 121 1
2 5
Pt. Dume
50
San Pedro
1 117 39
1
39 288 258 4
2 1
1 3
5 273 5
2
13 196
26
123 W
122 W
121 W
120 W
119 W
118 W
117 W
Longitude

In addition, there was:
89 days of effort between 35.8N and 37.2N
and 22 day of effort between 35.8N and 34.0N
3 days of effort between 34.0N and 33.4N
1 day of effort between 33.4N and 32.3N
7 days of effort without location

Figure 16. Set gillnet fishery estimated days of fishing effort by CDFG block for 1997.

Appendix 1. Fishery Descriptions


38 N
37 N
36 N
35 N
34 N
33 N
32 N
Latitude
123 W
122 W
121 W
120 W
119 W
118 W
117 W
Longitude
Monterey Bay
Morro Bay
Pt. Arguello
Pt. Dume
San Pedro
14
63 26 16
21 14 7 178
5
54
1
5
1 4
10
2 1 3 9 4
5 276 220 172
12 68 24 34 2 251
1 2 2 8
20 192
47 132 1
3
93 242 314
1
3
2 60 1
5 2 157 2
27
2

In addition, there was:
49 days of effort between 35.8N and 37.2N
and 1 day of effort between 35.8N and 34.0N.

Figure 17. Set gillnet fishery estimated days of fishing effort by CDFG block for 1998.

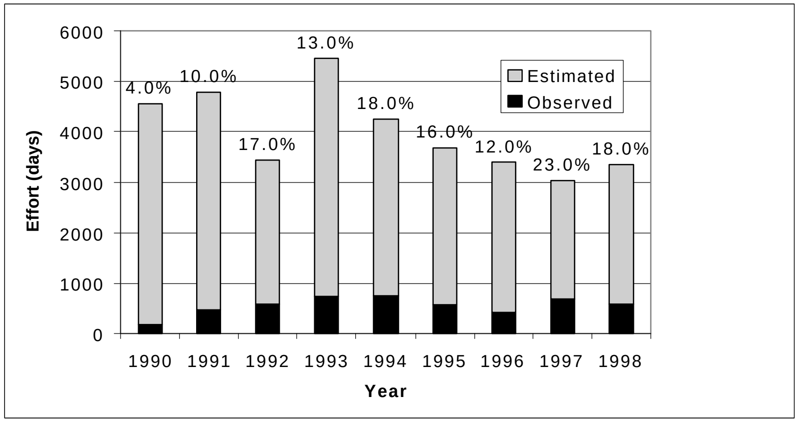


Figure 18. Estimated and observed drift-net fishery days of effort. Percent coverage is indicated above bars.

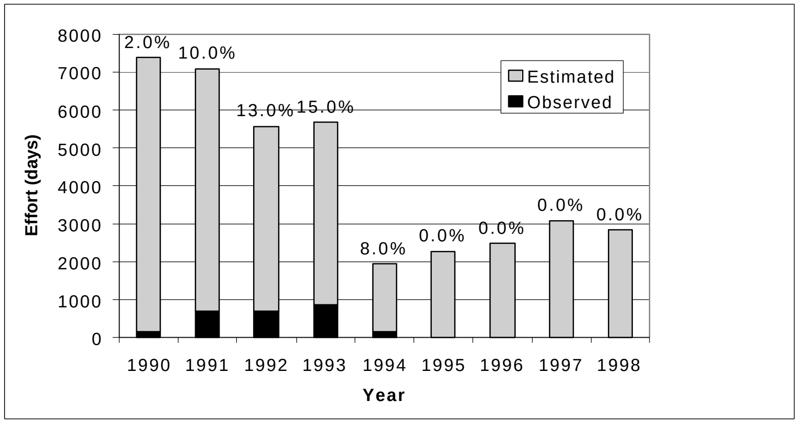


Figure 19. Estimated and observed set-net fishery days of effort. Percent coverage is indicated above bars.

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.

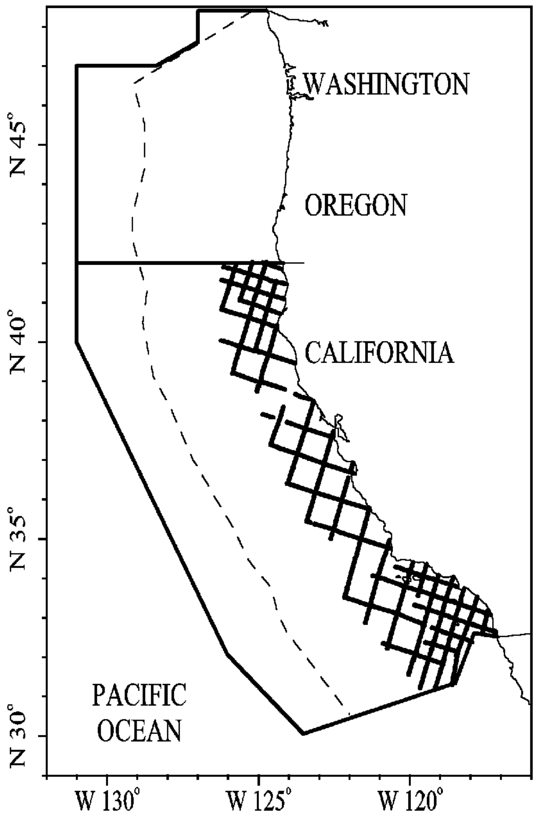

WASHINGTON
OREGON
CALIFORNIA
PACIFIC OCEAN
N 45°
N 40°
N 35°
N 30°
W 130°
W 125°
W 120°

Figure 1. Transect lines completed during a 1991 aerial survey of California waters. (Forney et al. 1995)

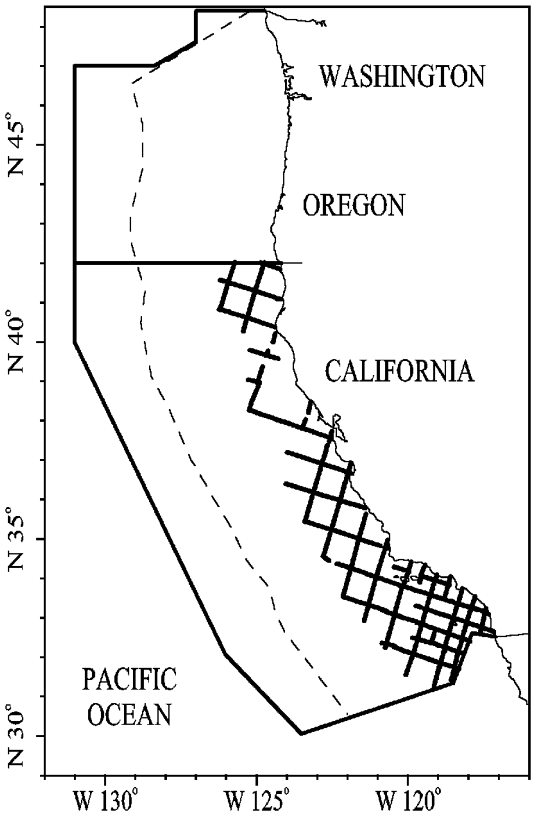

WASHINGTON
OREGON
CALIFORNIA
PACIFIC OCEAN
N 45°
N 40°
N 35°
N 30°
W 130°
W 125°
W 120°

Figure 2. Transect lines completed during a 1992 aerial survey of California waters (Forney et al. 1995).

Appendix 2. Cetacean Survey Effort

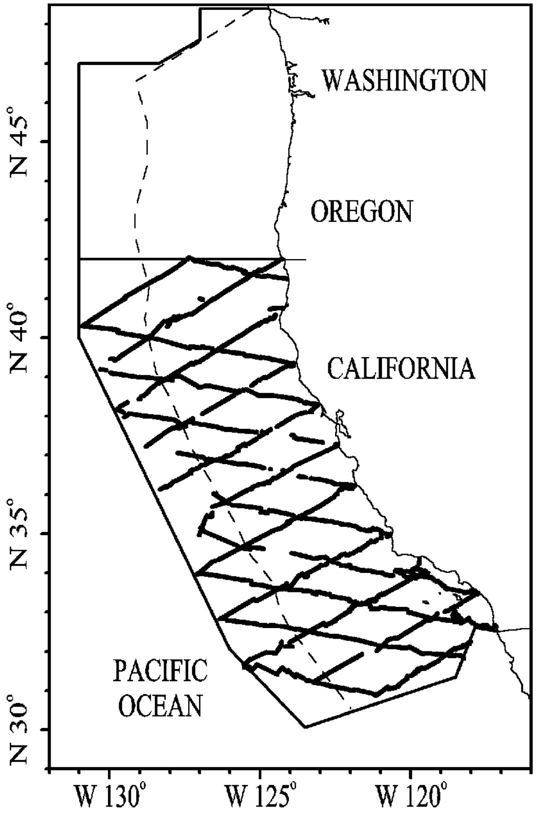

WASHINGTON
OREGON
CALIFORNIA
PACIFIC
OCEAN
N 45°
N 40°
N 35°
N 30°
W 130°
W 125°
W 120°

Figure 3. Transect lines completed during a 1991 vessel survey of California waters (Barlow 1995).

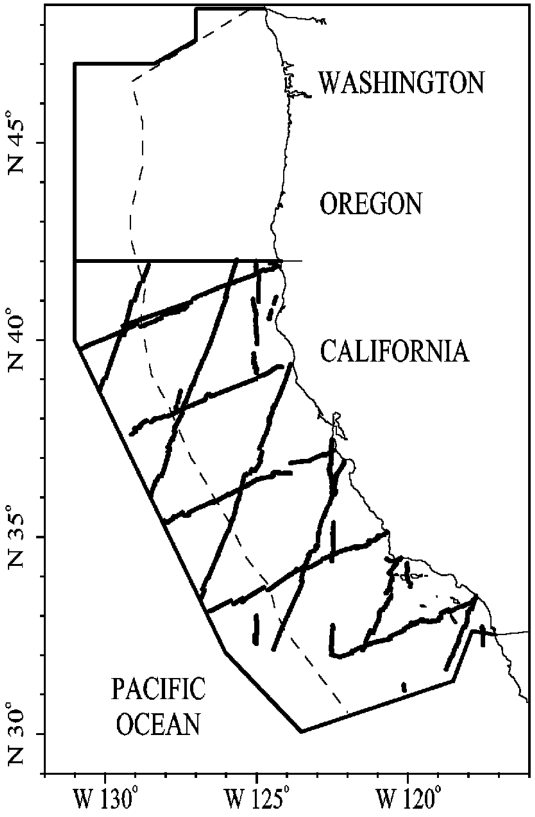

WASHINGTON
OREGON
CALIFORNIA
PACIFIC
OCEAN
N 45°
N 40°
N 35°
N 30°
W 130°
W 125°
W 120°

Figure 4. Transect lines completed during a 1993 vessel survey of California waters (Mangels and Gerrodette 1994)

Appendix 2. Cetacean Survey Effort

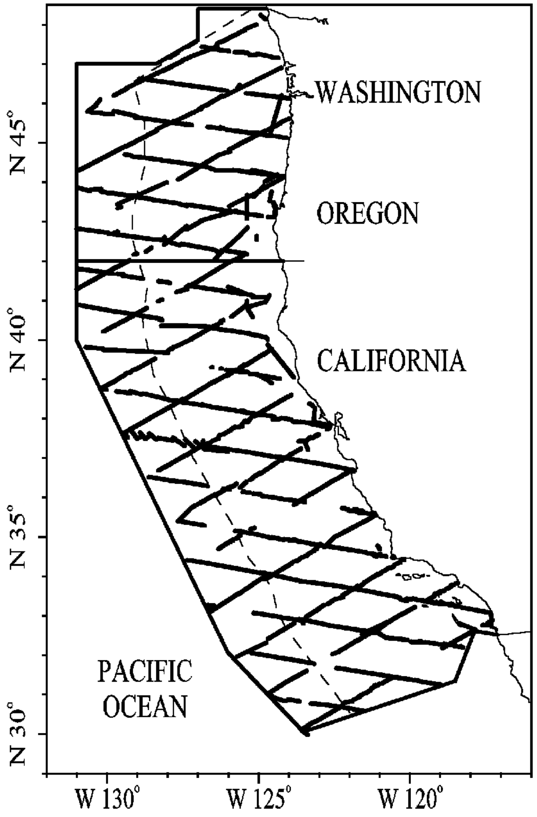

WASHINGTON
OREGON
CALIFORNIA
PACIFIC OCEAN
N 45°
N 40°
N 35°
N 30°
W 130°
W 125°
W 120°

Figure 5. Transect lines completed during a 1996 vessel survey of California, Oregon, and Washington waters (Barlow 1997; Von Saunder and Barlow 1999).

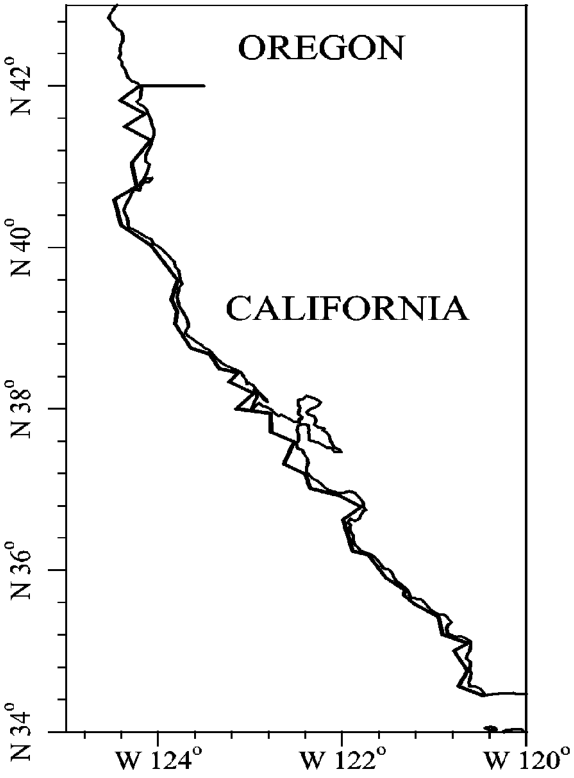

OREGON
CALIFORNIA
N 42°
N 40°
N 38°
N 36°
N 34°
W 124°
W 122°
W 120°

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

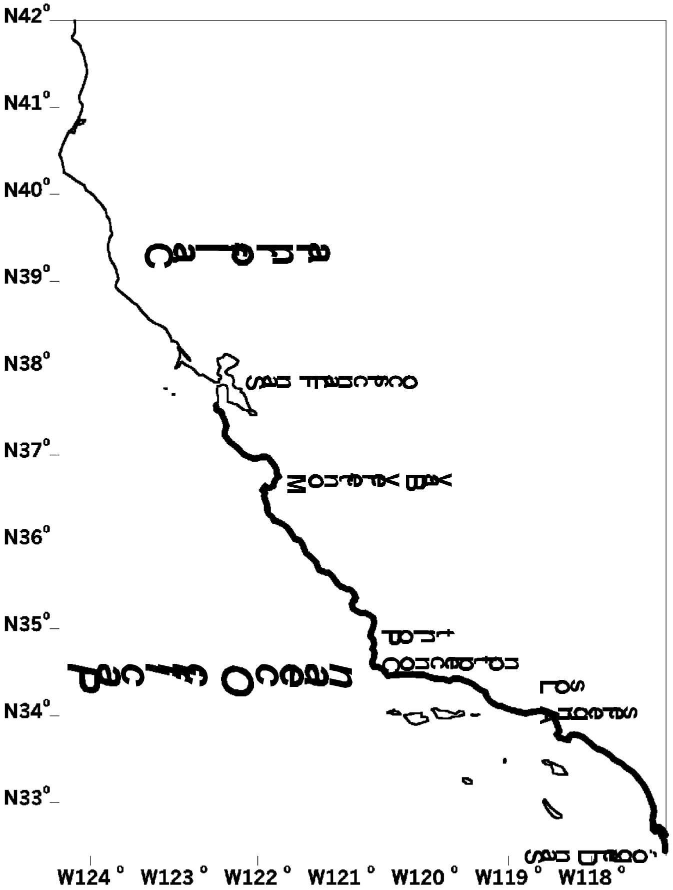

N42°
N41°
N40°
N39°
N38°
N37°
N36°
N35°
N34°
N33°
W124°
W123°
W122°
W121°
W120°
W119°
W118°

Figure 7. Coastline section (in bold) surveyed during 1990-1999 aerial surveys in southern and central California (Carretta et al. 1998).

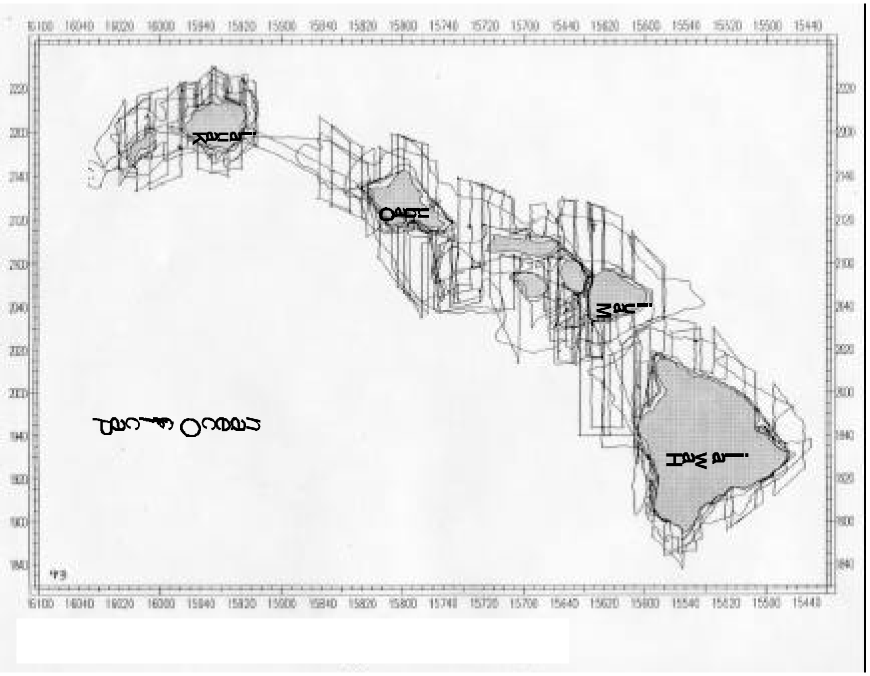


Figure 8. Transect lines completed during 1993 aerial surveys of the main Hawaiian islands (Mobley et al. 1999).

Appendix 2. Cetacean Survey Effort

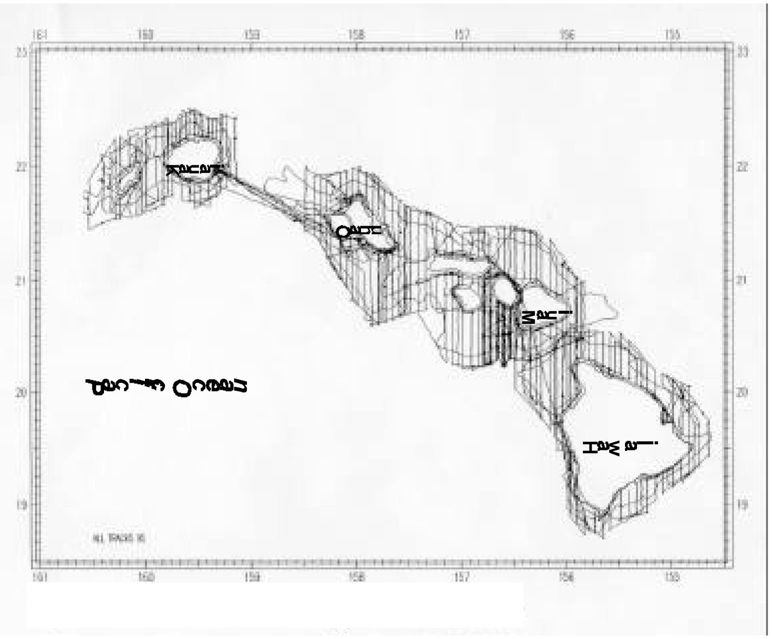

161
160
159
158
157
156
155
23
22
21
20
19

Figure 9. Transect lines completed during 1995 aerial surveys of the main Hawaiian Islands (Mobley et al. 1999).

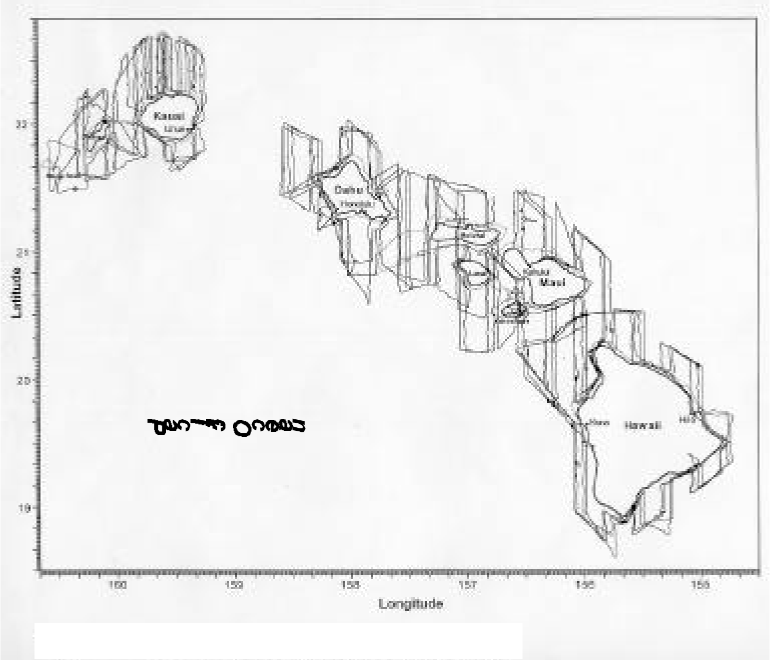

Kauai
Oahu
Honolulu
Maui
Hawaii
Kona
Hilo
Latitude
Longitude
22
21
20
19
160
159
158
157
156
155

Figure 10. Transect lines completed during 1998 aerial surveys of the main Hawaiian Islands (Mobley et al. 1999).

Appendix 2. Cetacean survey effort

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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 01/03/00)

SUMMARY OF 2000 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	~~111,339~~ 109,854	0.12	1.0	~~6,680~~ 6,591	~~974~~ 1,352	~~915~~ 1,208	N
Harbor Seal	California	PAC	SWC	27,962	0.12	1.0	1,678	~~243~~ ≥39	~~234~~ n/a	N
Harbor Seal	Oregon/ Washington Coast	PAC	AKC	~~24,733~~ 24,705	0.12	1.0	~~1,484~~ 1,482	~~19~~ ≥18	~~17~~ ≥16	N
Harbor Seal	Inland Washington	PAC	AKC	~~16,104~~ 15,174	0.12	1.0	~~966~~ 910	~~41~~ ≥43	~~36~~ ≥38	N
Northern Elephant Seal	California breeding	PAC	SWC	51,625	0.083	1.0	2,142	~~145~~ ≥33	~~145~~ ≥33	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	~~6,720~~ 2,336	0.086	1.0	~~216~~ 100	0.0	0.0	N
Monk seal	Hawaii	PAC	SWC	~~1,423~~ 1,436	0.07	0.1	5.0[1]	n/a	n/a	Y
Harbor porpoise	Central California	PAC	SWC	4,172	0.04	0.50	42	~~24~~ 63	~~24~~ 63	~~N~~ Y
Harbor porpoise	Northern California	PAC	SWC	~~7,640~~ 8,061	0.04	~~0.5~~ 1.0	~~76~~ 81	~~0.0~~ ≥0.2	~~0.0~~ ≥0.2	N
Harbor porpoise	Oregon/ Washington Coast	PAC	AKC	32,769	0.04	0.5	328	12	12	N
Harbor porpoise	Inland Washington	PAC	AKC	2,545	0.04	0.4	20	15	15	N
Dall's Porpoise	California/ Oregon/ Washington	PAC	SWC	~~34,393~~ 81,866	0.04	~~0.48~~ 0.45	~~330~~ 737	~~22~~ 12	~~22~~ 12	N
Pacific White-sided Dolphin	California/ Oregon/ Washington	PAC	SWC	~~82,939~~ 17,475	0.04	~~0.48~~ 0.45	~~796~~ 157	~~22.0~~ ≥6.8	~~22.0~~ ≥6.8	N

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[1] The Endangered Species Act takes precedence in the management of this species and, under the Act, allowable take is zero.

APPENDIX 3 (revised 01/03/00)

SUMMARY OF 2000 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	~~22,388~~ 13,079	0.04	~~0.5~~ 0.4	~~224~~ 105	~~37~~ 5.5	~~37~~ 5.5	N
Bottlenose Dolphin	California coastal	PAC	SWC	~~134~~ 154	0.04	0.5	~~1.3~~ 1.5	0	0	N
Bottlenose Dolphin	California/ Oregon/ Washington Offshore	PAC	SWC	~~1904~~ 850	0.04	~~0.4~~ 0.5	~~15~~ 8.5	~~4.4~~ 0	~~4.4~~ 0	N
Striped Dolphin	California/ Oregon/ Washington	PAC	SWC	~~19,248~~ 17,995	0.04	~~0.4~~ 0.5	~~154~~ 180	~~1.2~~ 0	~~1.2~~ 0	N
Common dolphin, short-beaked	California/ Oregon/ Washington	PAC	SWC	~~309,717~~ 318,795	0.04	0.5	~~3,097~~ 3,188	~~272~~ 79	~~272~~ 79	N
Common dolphin, long-beaked	California	PAC	SWC	~~5,504~~ 27,739	0.04	~~0.48~~ 0.45	~~53~~ 250	14	14	N
Northern right whale dolphin	California/ Oregon/ Washington	PAC	SWC	~~15,080~~ 10,060	0.04	~~0.5~~ 0.48	~~151~~ 97	~~47~~ 15	~~47~~ 15	N
Killer whale	Eastern North Pacific Transient	PAC	AKC	~~336~~ 376	0.04	0.45	~~3.0~~ 3.4	~~2.0~~ 2.6	~~2.0~~ 2.4	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	~~89~~ 84	0.04	0.5	~~0.9~~ 0.8	0	0	N
Short-finned pilot whale	California/ Oregon/ Washington	PAC	SWC	717	0.04	~~0.48~~ 0.4	~~6.9~~ 5.7	~~13~~ 3.0	~~13~~ 3.0	~~Y~~ N
Baird's Beaked Whale	California/ Oregon/ Washington	PAC	SWC	~~252~~ 313	0.04	~~0.4~~ 0.5	~~3.1~~ 2.0	~~1.2~~ 0	~~1.2~~ 0	N
Mesoplodont Beaked Whales	California/ Oregon/ Washington	PAC	SWC	~~2,840~~ 2,734	0.04	~~0.45~~ 0.5	~~26~~ 27	~~≥9.2~~ 0	~~9.2 - 13~~ 0	N
Cuvier's Beaked Whale	California/ Oregon/ Washington	PAC	SWC	~~6,070~~ 4,309	0.04	0.5	~~61~~ 43	~~28~~ 0	~~28~~ 0	N

APPENDIX 3 (revised 01/03/00)

SUMMARY OF 2000 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
Pygmy Sperm Whale	California/ Oregon/ Washington	PAC	SWC	~~2,059~~ 2,837	0.04	~~0.45~~ 0.5	~~19~~ 28	~~2.8~~ 0	~~2.8~~ 0	N
~~Dwarf Sperm Whale~~	~~California/ Oregon/ Washington~~	~~PAC~~	~~SWC~~	~~n/a~~	~~0.04~~	~~0.5~~	~~n/a~~	~~n/a~~	~~n/a~~	~~N~~
Sperm whale	California/ Oregon/ Washington	PAC	SWC	~~992~~ 995	0.04	0.1	2.0	~~3.0~~ 2.5	~~3.0~~ 2.5	Y
Humpback whale	California/ Oregon/ Washington	PAC	SWC	~~563~~ 861	0.04	0.1	~~0.5~~ 1.7	~~1.8~~ 1.4	1.2	Y
Blue whale	~~California/ Oregon/ Washington~~ Eastern North Pacific	PAC	SWC	~~1,463~~ 1,716	0.04	0.1	~~1.5~~ 1.7	~~0.2~~ 0.0	0	Y
Fin whale	California/ Oregon/ Washington	PAC	SWC	~~747~~ 1,044	0.04	0.1	~~1.5~~ 2.1	~~<1~~ 0.4	0	Y
Bryde's whale	California/ Oregon/ Washington	PAC	SWC	11,163	0.04	0.5	~~0.2~~ 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	~~3.6~~ 0	~~3.6~~ 0	N
Rough-Toothed Dolphin	Hawaii	PAC	SWC	~~n/a~~ 76	0.04	0.5	~~n/a~~ 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	~~n/a~~ 479	0.04	0.5	~~n/a~~ 4.8	n/a	n/a	N
Pantropical spotted dolphin	Hawaii	PAC	SWC	~~n/a~~ 2,040	0.04	0.5	~~n/a~~ 20	n/a	n/a	N
Spinner dolphin	Hawaii	PAC	SWC	~~677~~ 2,355	0.04	0.5	~~6.8~~ 24	n/a	n/a	N
Striped dolphin	Hawaii	PAC	SWC	~~n/a~~ 52	0.04	0.5	~~n/a~~ 0.5	n/a	n/a	N

APPENDIX 3 (revised 01/03/00)

SUMMARY OF 2000 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	~~n/a~~ 81	0.04	0.5	~~n/a~~ 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	~~n/a~~ 83	0.04	0.5	~~n/a~~ 0.8	~~n/a~~ 9.0	~~n/a~~ 9.0	~~N~~ 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	~~n/a~~ 1,313	0.04	0.5	~~n/a~~ 13	n/a	n/a	N
Blainville's beaked whale	Hawaii	PAC	SWC	~~n/a~~ 43	0.04	0.5	~~n/a~~ 0.4	n/a	n/a	N
Cuvier's beaked whale	Hawaii	PAC	SWC	~~n/a~~ 29	0.04	0.5	~~n/a~~ 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	~~n/a~~ 43	0.04	0.1	~~n/a~~ 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 01/03/00)

CHRONOLOGY OF U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS, 1995-2000.

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**
PINNIPEDS					
CALIFORNIA SEA LION (*Zalophus californianus californianus*): U.S. Stock	X	X			X
HARBOR SEAL (*Phoca vitulina richardsi*): California Stock	X	X			X
HARBOR SEAL (*Phoca vitulina richardsi*): Oregon & Washington Coastal Waters Stock	X	X	X		X
HARBOR SEAL (*Phoca vitulina richardsi*): Washington Inland Waters Stock	X	X	X		X
NORTHERN ELEPHANT SEAL (*Mirounga angustirostris*): California Breeding Stock	X	X			X
GUADALUPE FUR SEAL (*Arctocephalus townsendi*)	X	R			X
NORTHERN FUR SEAL (*Callorhinus ursinus*): San Miguel Island Stock	X	X	X		X
HAWAIIAN MONK SEAL (*Monachus schauinslandi*)	X	X		X	X
CETACEANS - U. S. WEST COAST					
HARBOR PORPOISE (*Phocoena phocoena*): Central California Stock	X	X		X	X
HARBOR PORPOISE (*Phocoena phocoena*): Northern California Stock	X	X		X	X
HARBOR PORPOISE (*Phocoena phocoena*): Oregon/Washington Coast Stock	X	X	X	X	X
HARBOR PORPOISE (*Phocoena phocoena*): Inland Washington Stock	X	X	X	X	X
DALL'S PORPOISE (*Phocoenoides dalli*): California/Oregon/Washington Stock	X	X			X
PACIFIC WHITE-SIDED DOLPHIN (*Lagenorhynchus obliquidens*): California/ Oregon/Washington, Northern and Southern Stocks	X	X			X
RISSO'S DOLPHIN (*Grampus griseus*): California/Oregon/Washington Stock	X	X			X
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California Coastal Stock	X	X			X
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California/Oregon/Washington Offshore Stock	X	X			X
STRIPED DOLPHIN (*Stenella coeruleoalba*): California/Oregon/Washington Stock	X	X			X

APPENDIX 4 (revised 01/03/00)

CHRONOLOGY OF U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS, 1995-2000.

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**
SHORT-BEAKED COMMON DOLPHIN (*Delphinus delphis*): California/Oregon/Washington Stock	X	X			X
LONG-BEAKED COMMON DOLPHIN (*Delphinus capensis*): California Stock	X	X			X
NORTHERN RIGHT WHALE DOLPHIN (*Lissodelphis borealis*): California/Oregon/Washington Stock	X	X			X
KILLER WHALE (*Orcinus orca*): California/Oregon/Washington Pacific Coast Stock	X	X		E	E
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock	X	X		X	X
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Transient Stock	(INCLUDED IN ALASKA REPORTS)			X	X
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Offshore Stock	▨	▨	▨	N	X
SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): California/Oregon/Washington Stock	X	X		X	X
BAIRD'S BEAKED WHALE (*Berardius bairdii*): California/Oregon/Washington Stock	X	X			X
MESOPLODONT BEAKED WHALES (*Mesoplodon* spp.): California/Oregon/Washington Stocks	X	X	X		X
CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): California/Oregon/Washington Stock	X	X			X
PYGMY SPERM WHALE (*Kogia breviceps*): California/Oregon/Washington Stock	X	X			X
DWARF SPERM WHALE (*Kogia simus*): California/Oregon/Washington Stock	X	X			E
SPERM WHALE (*Physeter macrocephalus*): California/Oregon/Washington Stock	X	X		X	X
HUMPBACK WHALE (*Megaptera novaeangliae*): California/Oregon/Washington - Mexico Stock	X	X		X	X
BLUE WHALE (*Balaenoptera musculus*): Eastern North Pacific Stock (previously called California/Oregon/ Washington stock prior to 2000 report)	X	X			X
FIN WHALE (*Balaenoptera physalus*): California/Oregon/Washington Stock	X	X			X
BRYDE'S WHALE (*Balaenoptera edeni*): Eastern Tropical Pacific Stock	X	X			X
SEI WHALE (*Balaenoptera borealis*): Eastern North Pacific Stock	X	X			X

APPENDIX 4 (revised 01/03/00)

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U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000
MINKE WHALE (*Balaenoptera acutorostrata*): California/Oregon/Washington Stock	X	X	X		X
CETACEANS - HAWAII					
ROUGH-TOOTHED DOLPHIN (*Steno bredanensis*): Hawaiian Stock	X	R			X
RISSO'S DOLPHIN (*Grampus griseus*): Hawaiian Stock	X	R			X
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): Hawaiian Stock	X	R			X
PANTROPICAL SPOTTED DOLPHIN (*Stenella attenuata*): Hawaiian Stock	X	R			X
SPINNER DOLPHIN (*Stenella longirostris*): Hawaiian Stock	X	R			X
STRIPED DOLPHIN (*Stenella coeruleoalba*): Hawaiian Stock	X	R			X
MELON-HEADED WHALE (*Peponocephala electra*): Hawaiian Stock	X	R			X
PYGMY KILLER WHALE (*Feresa attenuata*): Hawaiian Stock	X	R			X
FALSE KILLER WHALE (*Pseudorca crassidens*): Hawaiian Stock	X	R			X
KILLER WHALE (*Orcinus orca*): Hawaiian Stock	X	R			X
SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Hawaiian Stock	X	R			X
BLAINVILLE'S BEAKED WHALE (*Mesoplodon densirostris*): Hawaiian Stock	X	R			X
CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Hawaiian Stock	X	R			X
PYGMY SPERM WHALE (*Kogia breviceps*): Hawaiian Stock	X	R			X
DWARF SPERM WHALE (*Kogia simus*): Hawaiian Stock	X	R			X
SPERM WHALE (*Physeter macrocephalus*): Hawaiian Stock	X	R			X
BLUE WHALE (*Balaenoptera musculus*): Hawaiian Stock	X	R			X

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CHRONOLOGY OF U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS, 1995-2000.

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**
FIN WHALE (*Balaenoptera physalus*): Hawaiian Stock	X	R			X
BRYDE'S WHALE (*Balaenoptera edeni*): Hawaiian Stock	X	R			X
APPENDIX TITLES	**APPENDIX NUMBERS**				
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Cetacean Survey Effort		2			2
Review of New Information for Pacific Marine Mammal Stocks			2		
Chronology of U. S. Pacific Stock Assessment Reports, 1995-1999				1	4