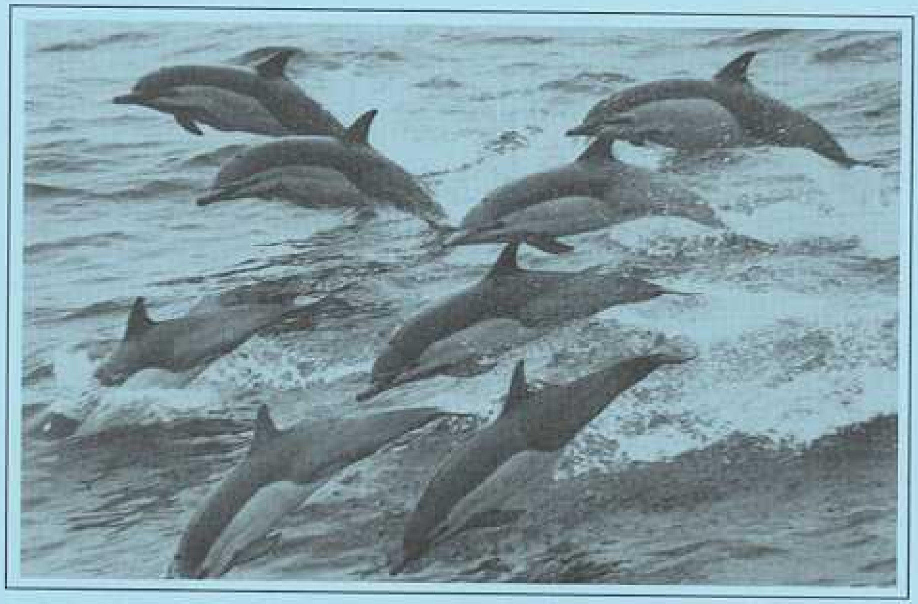
NOAA Technical Memorandum NMFS

OCTOBER 1997

# U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 1996



Jay Barlow, Karin A. Forney, P. Scott Hill, Robert L. Brownell, Jr., James V. Carretta, Douglas P. DeMaster, Fred Julian, Mark S. Lowry, Timothy Ragen, and Randall R. Reeves

NOAA-TM-NMFS-SWFSC-248

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

**NOAA Technical Memorandum NMFS**

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**U.S. DEPARTMENT OF COMMERCE**
William M. Daley, Secretary

**National Oceanic and Atmospheric Administration**
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**National Marine Fisheries Service**
Rolland A. Schmitten, Assistant Administrator for Fisheries

NOAA TECHNICAL MEMORANDUM
NOAA-TM-NMFS-SWFSC-248

# U. S. Pacific
# Marine Mammal Stock Assessments: 1996

by

**Jay Barlow, Karin A. Forney, P. Scott Hill, Robert L. Brownell, Jr.,
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**U. S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center
La Jolla, California 92038**

**October 1997**

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## APPENDICES

## 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) were required to produce stock assessment reports for all marine mammal stocks in waters within the U.S. Exclusive Economic Zone. The first stock assessment reports were published in 1995 (Barlow et al. 1995).

This is the first major revision of the NMFS marine mammal stock assessment reports for the Pacific Region. Some reports were not revised because no significant new information was available (all Hawaiian cetaceans and Guadalupe fur seals), but those reports are included here for completeness. This document contains the stock assessment reports for the U.S. Pacific marine mammal stocks under NMFS jurisdiction. Marine mammal species which are under the management jurisdiction of the USFWS are covered in separate reports. Information about fisheries in this area that do take or might take marine mammals is given in Appendix 1. Information about marine mammal abundance surveys is given in Appendix 2. A table summarizing all of the Pacific stock assessment reports is given in Appendix 3. Background information, guidelines for preparing stock assessment reports (Wade and Angliss 1997), and a summary of all stock assessment reports are available from the NMFS Office of Protected Resources .

This report was prepared by staff of the Southwest Fisheries Science Center, NMFS and the Alaska Fisheries Science Center, NMFS. The information presented here was compiled primarily from published sources, but additional unpublished information was included where it contributed to the assessments. The authors discourage citation of this report in lieu of citing previously published reports or citing the actual sources of unpublished information. The authors wish to thank those who provided unpublished data. We also thank the members of the Pacific Scientific Review Group for their valuable contributions and constructive criticism: Hannah Bernard, Robin Brown, Mark Fraker, Doyle Hanan, John Heyning, Steve Jeffries, Katherine Ralls, Michael Scott, and Terry Wright. Their comments greatly improved the quality of these reports. The Marine Mammal Commission, the Humane Society of the United States, the Marine Mammal Center, the Center for Marine Conservation, and Friends of the Sea Otter provided careful reviews and thoughtful comments on this and earlier versions of these reports. Special thanks to Paul Wade of the Office of Protected Resources for his exhaustive review and comments, which greatly enhanced the consistency and technical quality of the reports. Any omissions or errors are the sole responsibility of the authors.

Some of the revisions of the previous stock assessment reports result in significant changes in the status of some stocks. The CA/OR/WA stocks of Baird's beaked whales, Cuvier's beaked whales, and pygmy sperm whales are no longer considered "strategic". They were previously considered "strategic" based on incidental morality in the CA/OR drift gillnet fishery. For Baird's beaked whales, status changed because of a new, much higher abundance estimate. For the latter two species, status changed because a correction factor was applied in estimating their abundance to account for the large proportion of individuals that are submerged and not counted during ship surveys. The CA/OR/WA stock of minke whales has been added to the list of "strategic" stocks;

a single observation of mortality in the CA/OR drift gillnet fishery was the primary cause for this reclassification. Finally, a new (non-strategic) stock has been added in this report - - the southern resident stock of killer whales (in Washington inland waters). This stock was previously included with the resident form of killer whales in Alaska and was included in the Alaska Stock Assessment Reports.

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.


Barlow, J., R. L. Brownell, Jr., D. P. DeMaster, K. A. Forney, M. S. Lowry, S. Osmeck, T. J. Ragen, R. R. Reeves, and R. J. Small. 1995. U.S. Pacific marine mammal stock assessments. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-219. 162pp.

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

Revised 8/1/97

# 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.

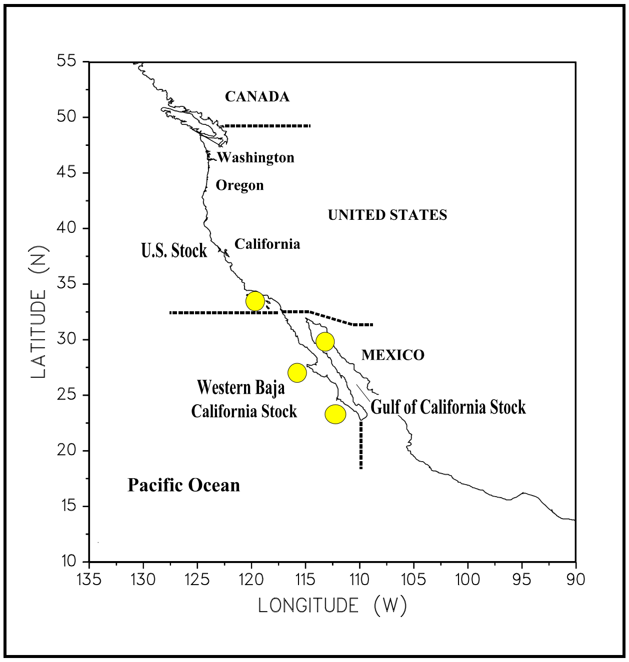


**Figure 1**. Geographic range of California sea lions showing stock boundaries and locations of major rookeries.

## 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 (37,818) was adjusted for an estimated 15% pre-census mortality (Boveng 1988; Lowry et al. 1992), giving an estimated 43,490 live births in the population. The fraction of newborn pups in the population (23.1% to 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% to 8.3% $yr^{-1}$, respectively, see below). Multiplying the number of pups born by the inverse of these fractions (4.32 to 3.85) results in population estimates ranging from 188,000 to 167,000 (respectively).

### Minimum Population Size

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

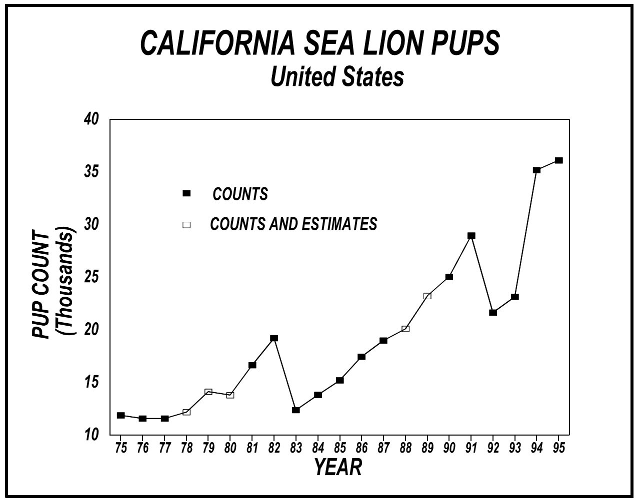


**Figure 2.** U.S. pup counts index for California sea lions.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The rate of net production is greater than the observed growth rate because fishery mortality takes a large fraction of the net production. Net productivity was, therefore, calculated for 1980-1995 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 (fishery mortality 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 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 for 1980 to 1995, respectively (Miller et al. 1983; Hanan et al. 1988; Hanan and Diamond 1989; Brown and Jeffries 1993; Barlow et al. 1994, Julian and Beeson in press.).

Between 1980 and 1995 the net productivity rate averaged 11.3% (Figure 3). A regression shows a slight increase in net production rates, but the regression is strongly influenced by the El Niño years (1983 and 1992) and the high net production rate for 1994. Maximum net productivity rates cannot be estimated from available data.

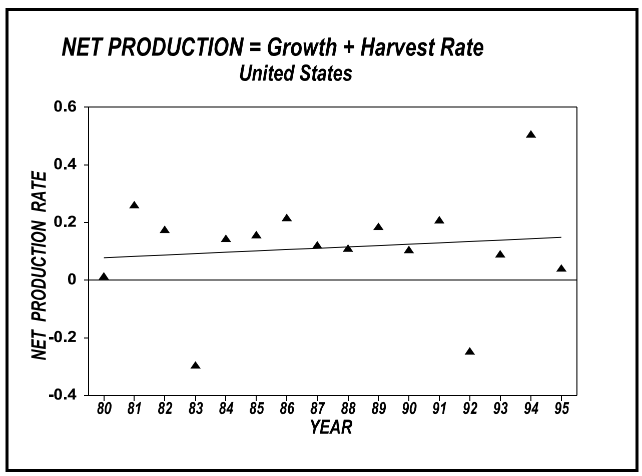


**Figure 3.** Net productivity rates and regression line estimated from pup counts with corrections for incidental harvest in commercial fisheries.

## POTENTIAL BIOLOGICAL REMOVAL

The Potential Biological Removal (PBR) for the United States stock of California sea lions is 6,680, based on a minimum population estimate of 111,339, a default $R_{max}$ value of 12%, and a recovery factor of 1.0 (unknown status, increasing significantly).

## ANNUAL HUMAN-CAUSED MORTALITY

## Fishery 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 and Beeson, in press; Table 1). Detailed information on these fisheries is provided in Appendix 1. Logbook and observer data, and reports, indicate that mortality of California sea lions occurs 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 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 additional mortalities occurred in 1995 as a result of fishing net entanglement and 2 additional mortalities from fishing hook 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. 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.

**Table 1.** Summary of available information on the incidental mortality and 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).

| 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<br>1992<br>1993<br>1994<br>1995 | observer | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 4<br>9<br>11<br>5<br>4 | 41 (0.58)<br>66 (0.34)<br>82 (0.42)<br>28 (0.40)<br>26 (0.45) | 49 (0.21) |
| **CA set gillnet fishery for halibut and angel shark** | 1991<br>1992<br>1993<br>1994<br>1995<br>1995 | observer<br><br><br><br>estimate<br>self-reporting | 9.8%<br>12.5%<br>15.4%<br>7.7%<br>0%<br>- | 142<br>338<br>237<br>109<br>-<br>10 | 1,842 (0.16)<br>3,418 (0.28)<br>1,942 (0.13)<br>905 (0.15)<br>724 (0.08) [1]<br>- | 815 (0.09) [2] |
| **OR Columbia R. gillnet fishery** | 1991<br>1992 | observer | 3.8%<br>3.9% | | 16 (1.0)<br>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<br><br>1993<br>1994 | logbook<br><br>observer | <br><br>2% non-Indian<br>7% both | <br><br>0<br>0 | Avg. Annual reported take = 24<br>0<br>0 | 12 |
| **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 ground fish trawl fishery** | 1991<br>1992<br>1993<br>1994<br>1995 | observer | 51.1% of catch<br>75.3% of catch<br>35.3% of catch<br>58.8% of catch<br>61.2% of catch | 0<br>0<br>0<br>1<br>0 | 0<br>0<br>0<br>2(0.68)<br>0 | 0.4 |
| **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 | logbook | | | 3.3/yr | not available |
| **Canada: BC salmon pen fishery** | 1991<br>1992<br>1993<br>1994<br>1995 | reports | | | 2<br>6<br>15<br>13<br>23 | 17 |
| **Minimum total annual takes** | | | | | | 915 |

[1] 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.

### Other Mortality

California sea lions that were injured by entanglement in 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). 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 from the California Marine Mammal Stranding Network database also shows the following non-fishery related mortality: boat collision (2 mortalities), entrainment in power plants (21 mortalities), and shootings (29 mortalities). Stranding records are a gross under-estimate of injury and mortality. 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 was 52.

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 fishery-related mortalities plus 59 from other sources) is less than the PBR (6,680). 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% per year, and the fishery mortality is declining.

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Revised 8/1/97

# 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 and three stocks in Alaska coastal and inland waters.

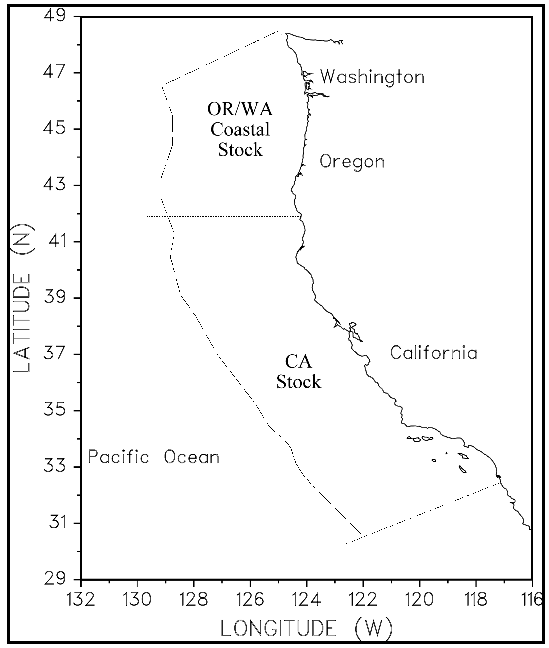


**Figure 4**. Stock boundaries for the California and Oregon/Washington coastal stocks of harbor seals.

## 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.

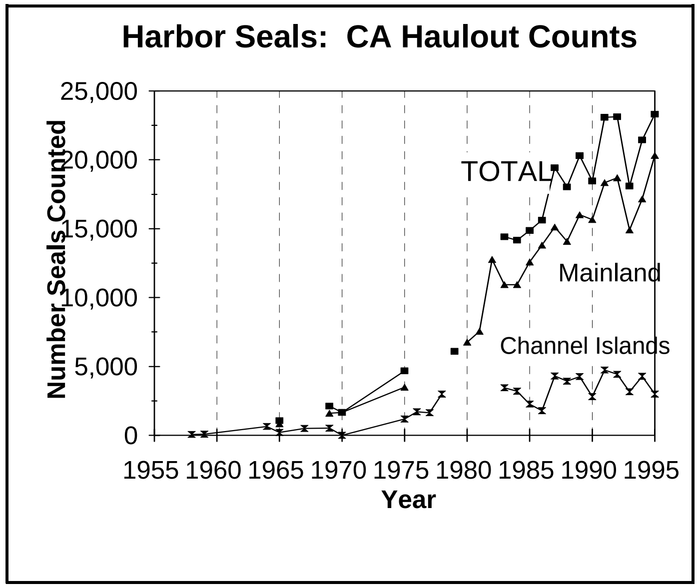


**Figure 5**. Harbor seal haulout counts in California during May/June (Hanan 1996).

**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 (Fig. 3).

**CURRENT AND MAXIMUM NET PRODUCTIVITY RATES**

A realized rate of increase was calculated for the 1982-19 95 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. Net productivity was therefore calculated for 1980-1994 as the realized rate of population growth (increase in seal counts from year *i* to year *i*+1, divided by the seal count in year *i*) plus the harvest 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.

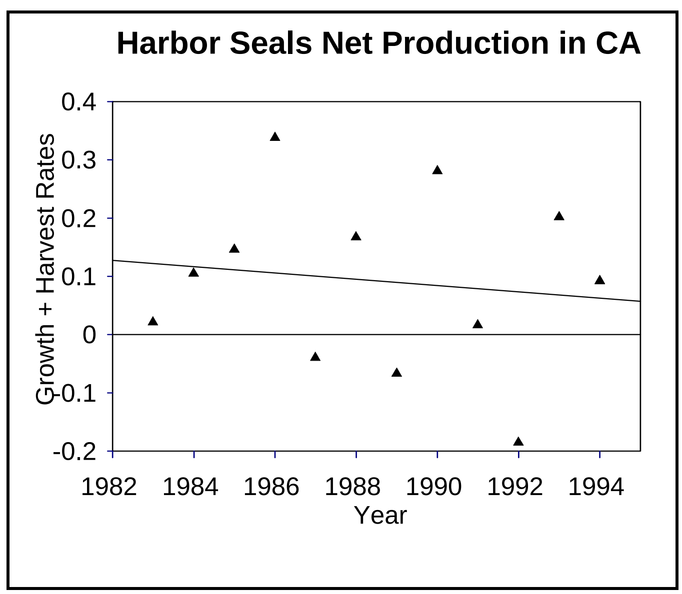


**Figure 6**. Net production rates and regression line estimated from haulout counts and fishery mortality.

## 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), resulting in a PBR of 1,678.

## ANNUAL HUMAN-CAUSED MORTALITY

### Historical Takes

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

### Fishery Information

A summary of known fishery mortality and injury for this stock of harbor seals is given in Table 1. More detailed information on these fisheries is provided in Appendix 1. Because the vast majority of harbor seal mortality in California fisheries occurs in the set gillnet fishery 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. 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 the California Marine Mammal Stranding Network indicate that 6 additional harbor seals died in 1995 from injuries caused by fishing hooks.

**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 and Beeson, in press, Appendix 1). 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 1994-95 (CV in parentheses) |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | 1991-95 | observer data | 10-18% | 0 | 0,0,0,0,0 | 0 |
| **CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery** | 1991<br>1992<br>1993<br>1994<br>1995<br>1995 | observer data<br><br><br><br>estimate<br>self-report | 9.8%<br>12.5%<br>15.4%<br>7.7%<br>0.0%<br>- | 42<br>90<br>71<br>23<br>-<br>2 | 601 (0.23)<br>1,204 (0.47)<br>475 (0.13)<br>227 (0.33)<br>228 (0.13) [1]<br>- | 228 (0.18) [2] |
| **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 | stranding data | | | 6 | 6 |
| **Total annual takes** | | | | | | >234 (0.18) |

[1] 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.

### 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 in 1995: (1) boat collision (1 mortality), (2) entrainment in power plants (5 mortalities), and (3) shootings (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) is less than the calculated PBR for this stock (1,678), they would not be considered a "strategic" stock under the MMPA. The average rate of incidental fishery mortality for this stock 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.

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Revised 8/1/97

# HARBOR SEAL (*Phoca vitulina richardsi*): Oregon & Washington Coastal Waters Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the continental U. S., British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice, and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944, Fisher 1952, Bigg 1969, 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).

For management purposes, differences in mean pupping date (Temte 1986), movement patterns (Jeffries 1985, Brown 1988), pollutant loads (Calambokidas 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 to 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 coastal waters stock, with stock assessment reports for the Washington Inland waters stock and California stock appearing in this volume. 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.

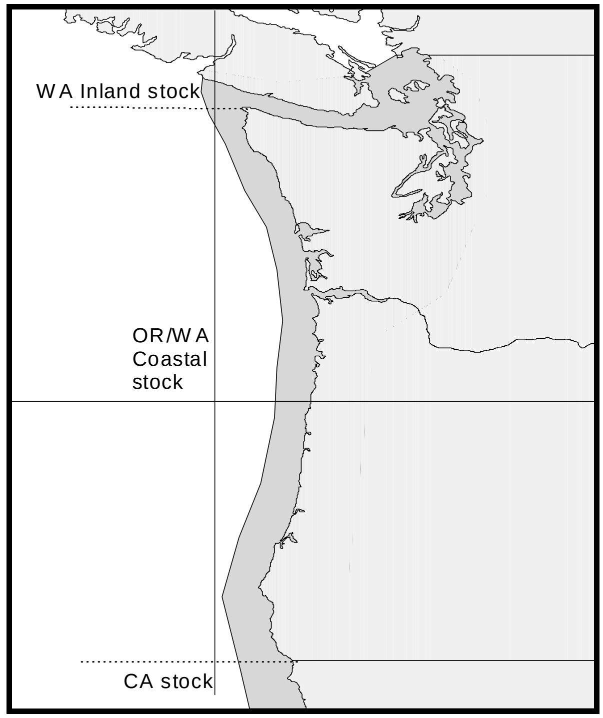


**Figure 1.** Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

## 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 pupping seasons of 1991, 1992, and 1993. Total numbers of hauled-out seals (including pups) were counted during these surveys. In 1993 the mean count of harbor seals occurring along the Oregon and Washington coasts was 17,733 (CV=0.012), slightly less than the 1992 count of 18,596 (CV=0.020) seals (Huber 1995, H. Huber unpubl. data, S. Jeffries unpubl. data, R. Brown unpubl. data). 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). Utilizing this correction factor results in a population estimate of 27,131 (17,733 x 1.53; CV=0.066) for the Oregon and Washington coastal waters stock of harbor seals in 1993.

**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 27,131 and its associated CV of 0.066, $N_{MIN}$ for this stock is 25,665.

**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 1969). 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 17,733 in 1993 (Huber 1995, H. Huber unpubl. data, S. Jeffries unpubl. data, R. Brown unpubl. data).

Uncorrected counts in 1991, 1992 and 1993 were 17,920, 18,596, and 17,733, respectively (Huber et al. 1993, Huber 1995, H. Huber unpubl. data, S. Jeffries unpubl. data, R. Brown unpubl. data). It is unclear whether the recent counts signify a slowing in the rate of increase for the Oregon/Washington coastal waters stock, are the result of environmental effects (such as oceanographic conditions or food availability related to El Niño), or whether the stock may be near carrying capacity (Huber 1995). Analysis of aerial survey data from 1994 and 1995 is currently underway.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

From 1978 to 1993, counts of harbor seals throughout Washington state have increased at an annual rate of 7.68% (Huber 1995). The Oregon and Washington coastal waters harbor seal stock increased at an annual rate of 11% from 1977-82, and then at 5.5% from 1983-1992 (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. However, until additional data become available, the pinniped maximum theoretical net productivity rate ($R_{MAX}$) of 12% will be employed for this harbor seal 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. Though the increasing trend in abundance may be slowing, the recovery factor ($F_R$) for this stock is 1.0, the value for stocks of unknown status that are increasing with no evidence of changes in the level of incidental mortality (Wade and Angliss 1997). Thus, for the Oregon and Washington coastal waters stock of harbor seals, PBR = 1,540 animals (25,665 x 0.06 x 1.0).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

**Fisheries Information**

With the exception of 1994, NMFS observers recorded harbor seal mortality incidental to the northern Washington marine set gillnet fishery during 1990-1995 (Gearin et al. 1994; P. Gearin, unpubl. data). For the entire fishery, observer coverage ranged from approximately 47-87% during those years. Fishing effort is conducted within the range of both stocks of harbor seals (Oregon/Washington coastal waters and Washington Inland waters 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 Washington Inland waters 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 waters 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 Washington Inland waters stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon/Washington coastal waters 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 coastal waters stock (those waters south and west of Cape Flattery). Data from 1990-95 are included in the table, although the mean estimated annual mortality is calculated using only the most recent 3 years of data (1991, 1992 and 1995). No fishing effort occurred in the coastal portion of the fishery in 1993 and, as noted above, no observer program occurred in 1994. The mean estimated mortality from 1991-95 for this fishery is 4.3 (CV=0.68) harbor seals per year from this stock.

The Washington and Oregon Lower Columbia River drift gillnet fishery was monitored during 1991-93 (Brown and Jeffries 1993, Matteson et al. 1993, Matteson and Langton 1994a). In 1991, observers recorded 9 harbor seal mortalities incidental to the fishery, resulting in an extrapolated estimated total 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 incidental to the fishery was observed. 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, during the 1994 the fishery was open for only 3 days and in 1995 there was no 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.

**Table 1.** Summary of incidental mortality of harbor seals (Oregon and Washington coastal waters stock) due to commercial fisheries from 1990 through 1995 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from logbook reports. n/a indicates that data are not available.

| Fishery name | Years | Data type | Range of observer coverage | Observed mortality (in given yrs.) | Estimated mortality (in given yrs.) | Mean annual mort. |
|---|---|---|---|---|---|---|
| Northern WA marine set gillnet | 90-95 | obs data | 68-100% | 5, 7, 0, n/a, n/a, 3 | 6, 10, 0, n/a, n/a, 3 | 4.3 (CV=.68) |
| WA/OR lower Columbia River drift gillnet | 91-93 | obs data | 5-27% | 9, 15, 1 | 233, 192, n/a | n/a (see text) |
| WA Grays Harbor salmon drift gillnet | 91-93 | obs data | 4-5% | 0, 1, 1 | 0, 10, 10 | 6.7 (CV=.50) |
| WA Willapa Bay drift gillnet | 91-93 | obs data | 1-3% | 0, 0, 0 | 0, 0, 0 | 0 |
| WA/OR/CA groundfish trawl (Pacific whiting component) | 90-95 | obs data | 44-72% | 0, 0, 0, 0, 0, 0 | 0, 0, 0, 0, 0, 0 | 0 |
| Observer program total | | | | | | 11 |
| | | | | **Reported mortalities** | | |
| WA Willapa Bay drift gillnet | 90-93 | logbook | n/a | 0, 0, 6, 8 | n/a | [$3.5] |
| WA/OR salmon net pens | 90-93 | logbook | n/a | 0, 2, 0, 0 | n/a | [$0.5] |
| Minimum total annual mortality | | | | | | $15 |

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 is 10 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 most recent 3 years of data for the northern Washington marine set gillnet (4.3) and Washington Grays Harbor salmon drift gillnet (6.7) fisheries results in an estimated mean mortality rate in observed fisheries of 11 harbor seal 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 logbook mortalities were 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 logbook 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 logbook reports maintained by vessel operators as required by the MMPA interim exemption program. During the 4-year period between 1990 and 1993, logbook reports from 2 unobserved fisheries (Table 1) resulted in an annual mean of 4 harbor seal mortalities from interactions with commercial fishing gear. However, because logbook records are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Complete logbook data after 1993 are not available.

**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 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) does not exceed the PBR (1,540). Therefore, the Oregon and Washington coastal waters stock of harbor seals is not classified as a strategic stock. The minimum total fishery mortality and serious injury for this stock (15; based on observer data (11) and logbook reports (4) where observer data were not available or failed to detect harbor seal mortality) is also less than 10% of the calculated PBR (154) and, therefore, can be 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 OSP.

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

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the continental U. S., British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice, and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944, Fisher 1952, Bigg 1969, 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).

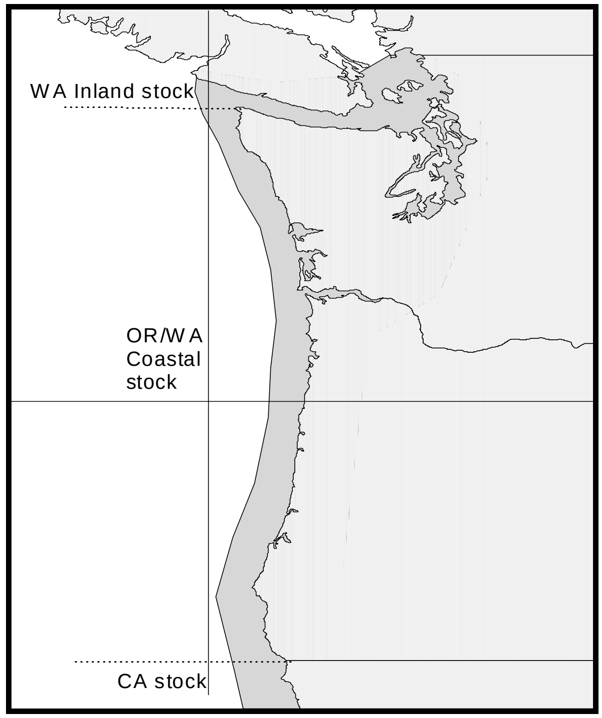


**Figure 1.** Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

For management purposes, differences in mean pupping date (Temte 1986), movement patterns (Jeffries 1985, Brown 1988), pollutant loads (Calambokidas 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 to this stock structure (Huber et al. 1994, Burg 1996, Lamont et al. 1996). Samples from Washington, Oregon, and California demonstrate a high level of genetic diversity and indicate that the harbor seals of inland Washington possess unique haplotypes not found in seals from the coasts of Washington, Oregon, and California (Lamont et al. 1996). This report considers only the Washington Inland waters stock, with stock assessment reports for the Oregon/Washington and California coastal waters stocks appearing in this volume. 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 1991, 1992, and 1993, during which time the total number of hauled-out seals (including pups) were counted (Huber et al. 1993, Huber 1995). In 1993 the mean count of harbor seals occurring in Washington's inland waters was 10,623 (CV=0.020), the highest count recorded during the 3-year period (Huber 1995). 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). Utilizing this correction factor results in a population estimate of 16,253 (10,623 x 1.53; CV=0.068) for the Washington Inland waters stock of harbor seals.

**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 16,253 and its associated CV of 0.068, $N_{MIN}$ for this stock is 15,349.

**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). More recently, counts of this stock have increased steadily from 6,062 in 1984 to 10,623 in 1993 (Boveng 1988, Huber 1995).

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

From 1978 to 1993, counts of harbor seals in Washington state have increased at an annual rate of 7.68% (Huber 1995). 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 maximum theoretical net productivity rate ($R_{MAX}$) of 12% will be employed for this harbor seal stock (Wade and Angliss 1997).

## POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 re-authorized 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 = $N_{MIN}$ x $0.5R_{MAX}$ x $F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for stocks of unknown status that are increasing with no evidence of changes in the level of incidental mortality (Wade and Angliss 1997). Thus, for the Washington Inland waters stock of harbor seals, PBR = 921 animals (15,349 x 0.06 x 1.0).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

**Fisheries Information**

With the exception of 1994, NMFS observers have recorded harbor seal mortality incidental to the northern Washington marine set gillnet fishery during 1990-1995 (Gearin et al. 1994; P. Gearin, unpubl. data). For the entire fishery, observer coverage ranged from approximately 47-87% during those years. Fishing effort is conducted within the range of both stocks of harbor seals (Oregon/Washington coastal waters and Washington Inland waters 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 coastal waters stock for details) may have been from the inland waters 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 Washington Inland waters stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon/Washington coastal waters 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 Washington Inland waters stock (those waters east of Cape Flattery). Data from 1990-95 are included in Table 1, although the mean estimated annual mortality is calculated using only the most recent 3 years of data (1992, 1993, and 1995). As noted above, there was no observer program in 1994. Little effort occurred in the inland portion of the fishery in 1995, observer coverage was lower than usual (24%), and no mortalities were observed. The mean estimated mortality from 1992-1995 for this fishery is 11 (CV=0.53) 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.

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.

**Table 1.** Summary of incidental mortality of harbor seals (Washington Inland waters stock) due to commercial fisheries from 1990 through 1995 and calculation of the mean annual mortality rate. n/a indicates that data are not available.

| **Fishery name** | **Years** | **Data type** | **Range of observer coverage** | **Observed mortality (in given yrs.)** | **Estimated mortality (in given yrs.)** | **Mean annual mortality** |
|---|---|---|---|---|---|---|
| Northern WA marine set gillnet | 90-95 | obs data | 24-74% | 4, 8, 10, 12, n/a, 0 | 10, 13, 13, 20, n/a, 0 | 11 (CV=.53) |
| 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 (CV is n/a) |
| 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 (CV=1.0) |
| Observer program total | | | | | | 36 |
| | | | | **Reported mortalities** | | |
| WA Puget Sound Region salmon set/drift gillnet | 90-93 | logbook | n/a | 13, 43, 22, 16 | n/a | see text |
| Minimum total annual mortality | | | | | | $36 |

Also in 1994, the 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.

Combining the estimates from the northern Washington marine set gillnet (11), 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 minimun annual mortality rate in observed fisheries of 36 harbor seal 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, 36 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 logbook reports maintained by vessel operators as required by the MMPA interim exemption program. Logbook reports from 1990-93 for the Washington Puget Sound Region salmon set and drift gillnet fishery are shown in Table 1. Unlike the 1994 observer program data, the logbook data cover the entire fishery (including treaty and non-treaty components) and have thus been included below. However, as logbook records are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates of harbor seal mortality. Complete logbook data after 1993 are not available.

Though the observer program data underestimates total mortality for this stock, it considered more reliable than the logbook data. Thus, the logbook data were not used in the fishery mortality rate calculation. 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.

**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 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 (36) does not exceed the PBR (921). Therefore, the Washington Inland waters stock of harbor seal is not classified as a strategic stock. At present, annual mortality levels less than 92 animals per year (i.e., 10% of PBR) can be 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 OSP.

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Revised 8/1/97

# 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.

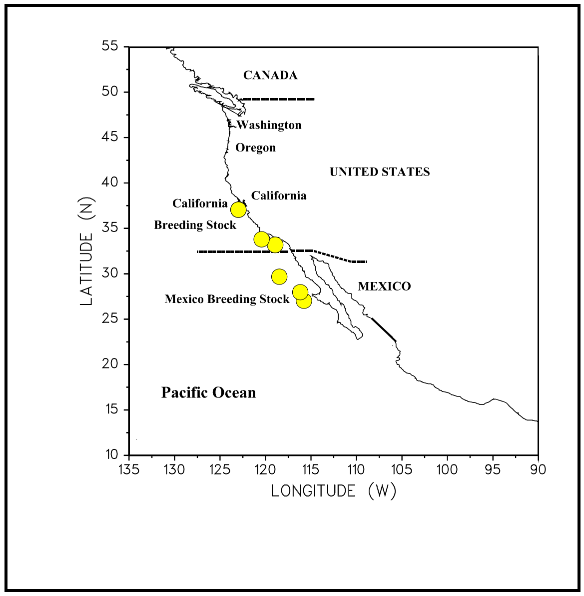


**Figure 1**. Stock boundary and major rookery areas for northern elephant seals in the U.S. and Mexico.

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.

## 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 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 Beauf 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 to be leveling off in California over the last 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 rate (fishery mortality in year *i* divided by population size in year *i*)].

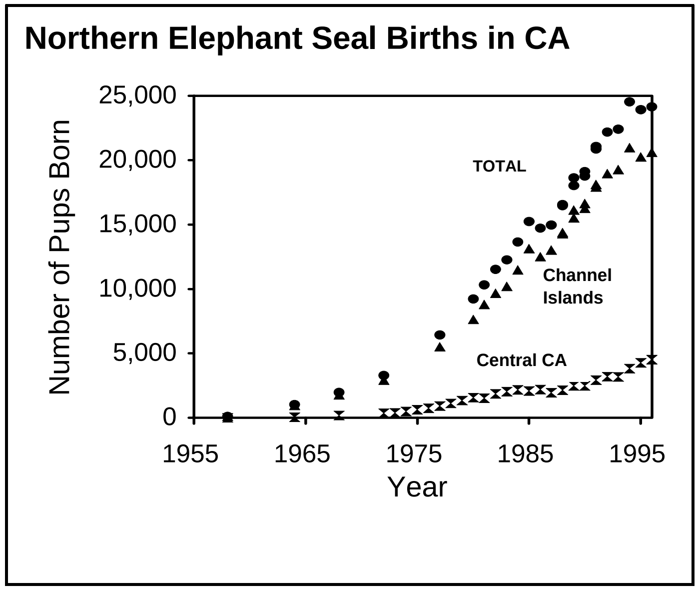


**Figure 2**. Estimated number of northern elephant seal births in California. Multiple independent estimates are presented for the Channel Islands 1988-91. Estimates are from Stewart et al. (1994), Lowry et al. (1996), and unpublished data from S. Allen, B. Hatfield, R. Jameson, B. Le Boeuf, M. Lowry, and W. Sydeman.

## POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (51,625) <u>times</u> one half the observed maximum net growth rate for this stock (1/2 of 8.3%) <u>times</u> a recovery factor of 1.0 (for a species of unknown status that is increasing) resulting in a PBR of 2,142.

## ANNUAL HUMAN-CAUSED MORTALITY

### Fisheries Information

A summary of known fishery mortality and injury for this stock of northern elephant seals is given in Table 1. More detailed information on these fisheries is provided in Appendix 1. The average estimated annual mortality for northern elephant seals in these fisheries for the five most recent years of monitoring (1991-95) is 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).

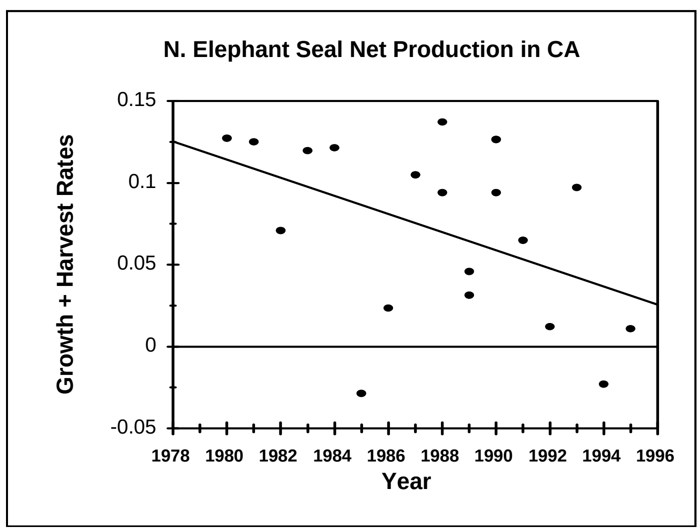


**Figure 3**. Net production rates for northern elephant seals in California based on pup births and fishery mortality. Annual mortality for 1980-1987 is assumed to be 300, the average of 1988-90 values (Perkins et al. 1994).

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. 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).

**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 and Beeson, in press; Perez, in prep.; NMFS unpubl. data). n/a indicates information is not available.

| 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<br>1992<br>1993<br>1994<br>1995 | observer data | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 13<br>15<br>14<br>22<br>14 | 132 (0.25)<br>110 (0.24)<br>105 (0.26)<br>123 (0.23)<br>90 (0.25) | 106 (0.11) |
| **CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery** | 1991<br>1992<br>1993<br>1994<br>1995 | observer data<br><br><br><br>estimate | 9.8%<br>12.5%<br>15.4%<br>7.7%<br>0% | 3<br>7<br>11<br>2<br>- | 30 (0.55)<br>51 (0.35)<br>70 (0.27)<br>16 (0.66)<br>47 (0.29) [1] | 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 | 0.4 |
| **Chehalis River salmon setnet fishery** | 1993 | personal communication | n/a | 4 | 4 | 1 |
| **Total annual takes** | | | | | | 145 (0.10) |

[1] 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.

## 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 mortality rate is much less than the calculated PBR for this stock, 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 (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). 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 at Guadalupe Island, 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. Maravilla, pers. comm. 1994). The population is considered to be a single stock because they pup and breed only at Guadalupe Island, Mexico.

## 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

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).

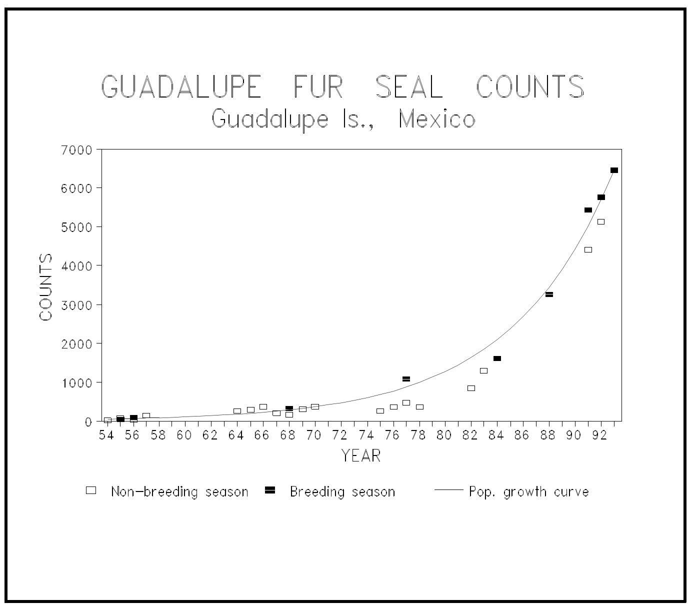


**Figure 1**. Counts of Guadalupe fur seals at Guadalupe Island, Mexico and the estimated population growth curve derived from counts made during the breeding season.

## CURRENT AND MAXIMUM 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 the Guadalupe fur seal is 104. This PBR value was derived from a minimum population estimate of 3,028, an $R_{max}$ value of 13.7%, and a recovery factor of 0.5 (for a threatened species). The vast majority of this PBR would apply towards incidental mortality in Mexico.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY RATE

### Fishery Information

In the United States there have been no reports of gillnet mortalities or injuries for Guadalupe fur seals (Lennert et al. 1991, Perkins et al. 1992, Julian et al. 1993, 1994, Barlow et al. 1994). No information is available for human-cause mortalities or injuries in Mexico.

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. 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. The number of set gillnets used in Mexico is unknown.

## 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 8/1/97

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

## STOCK DEFINITION AND GEOGRAPHIC RANGE

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

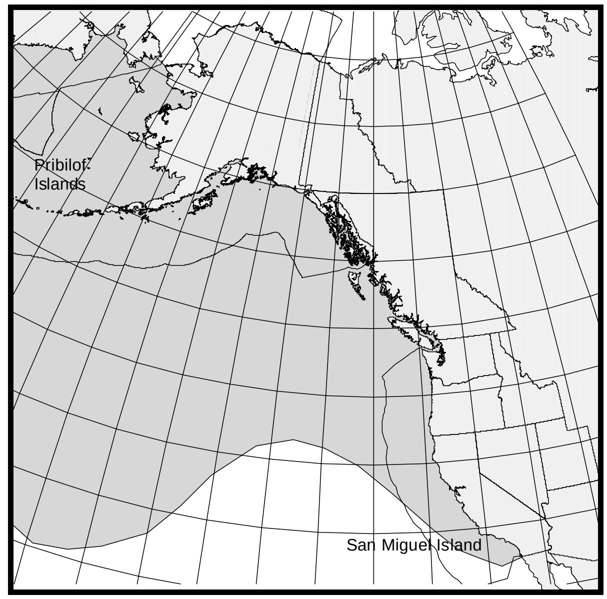

**Figure 1.** Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

Due to differing requirements during the annual reproductive season adult males and females typically occur ashore at different, though overlapping times. Adult males usually occur on shore during the 4-month period from May-August, though some may be present until November (well after giving up their territories). Adult females are found ashore for as long as six months (June-November). After their respective times ashore, seals of both genders spend the next 7-8 months at sea (Roppel 1984). Adult females and pups from the Pribilof Islands migrate through the Aleutian Islands into the North Pacific Ocean, often to the Oregon and California offshore waters. Many pups may remain at sea for 22 months before returning to their rookery of birth. Adult males from the Pribilof Islands generally migrate only as far south as the Gulf of Alaska (Kajimura 1984). There is considerable interchange of individuals between rookeries. The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: (1) Distributional data: geographic distribution is continuous during feeding, geographic separation during the breeding season, high natal site fidelity (DeLong 1982); (2) Population response data: substantial differences in population dynamics between Pribilofs and San Miguel Island (DeLong 1982, DeLong and Antonelis 1991, NMFS 1993); (3) Phenotypic data: unknown; and (4) Genotypic data: unknown. Based on this information, two separate stocks of northern fur seals are recognized within U. S. waters: an Eastern Pacific stock and a San Miguel Island stock. The Eastern Pacific stock is reported separately in the Stock Assessment Reports for the Alaska Region.

## POPULATION SIZE

The population estimate for the San Miguel Island stock of northern fur seals is calculated as the estimated number of pups at rookeries multiplied by an expansion factor. Based on research conducted on the Eastern Pacific stock of northern fur seals, a life table analysis was performed to estimate the number of yearlings, 2 year olds, 3 year olds, and animals at least 4 years old (Lander 1981). The resulting population estimate was equal to the pup count multiplied by approximately 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 increased mortality and possible emigration of adults associated with the El Niño Southern Oscillation event in 1982-1983 (DeLong, pers. comm.). The most recent pup count occurred in 1995, resulting in a total count of 2,509 (NMFS, unpubl. data), slightly lower than the 1994 total pup count of 2,634 (Melin et al. 1996). Based on the 1995 count and the expansion factor, the most recent population estimate of the San Miguel Island stock is 10,036 (2,509 x 4.0) northern fur seals. Currently, a CV for the expansion factor is unavailable.

### Minimum Population Estimate

The survey technique utilized for estimating the abundance of northern fur seals within the San Miguel Island stock is a direct count, with no associated CV 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 using Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Rather, $N_{MIN}$ is estimated very conservatively as twice the maximum number of pups born in 1995 or 5,018 (2,509 x 2) animals. This approach was recommended by the Pacific Scientific Review Group in absence of alternative methods.

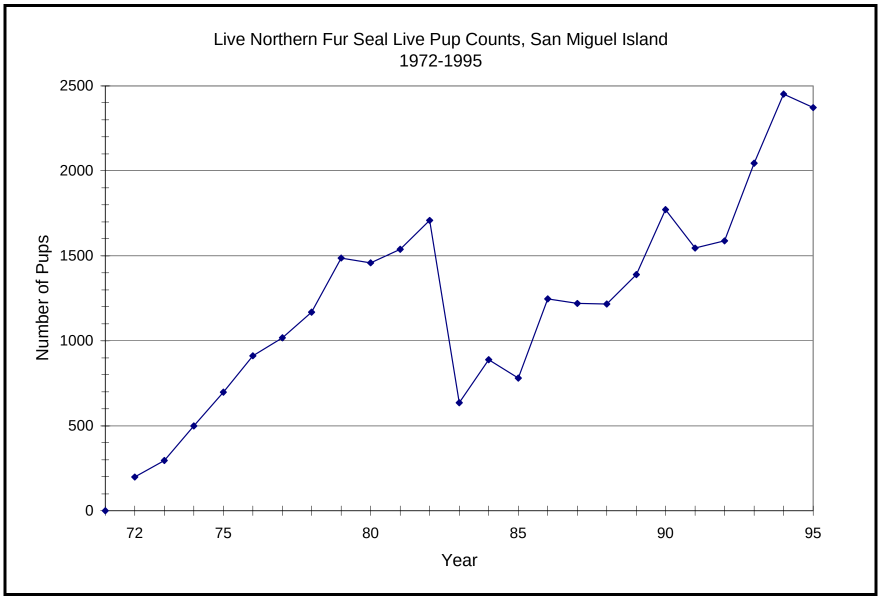


**Figure 2.** Northern fur seal live pup counts on San Miguel Island, 1972-1995.

### Current Population Trend

The population of northern fur seals on San Miguel Island has increased steadily since the early 1970s, except during the El Niño Southern Oscillation event in 1982-1983. 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). 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 (Fig. 2). The 1994 live pup count of 2,452 was the highest reported at the San Miguel colony since it was discovered in 1968 (Melin et al. 1996).

## 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

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 = $N_{MIN}$ x $0.5R_{MAX}$ x $F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for stocks of unknown status that are increasing with no evidence of change in the level of incidental mortality (Wade and Angliss 1997). Thus, for the San Miguel Island stock of northern fur seals, PBR = 216 animals (5,018 x 0.043 x 1.0).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

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 1990-95. 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 and Beeson in press). For this fishery, only data through 1994 are included in Table 1 because there were no observed sets in 1995. The estimated mean mortality rate in observed fisheries is zero northern fur seals per year.

An additional source of information on the number of northern fur seals killed or injured incidental to commercial fishery operations is the logbook reports maintained by vessel operators as required by the MMPA interim exemption program. During the 4-year period between 1990 and 1993, logbook reports from 2 fisheries (Table 1) reported mortalities of northern fur seals. 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. Mortality of northern fur seals incidental to these fisheries, if it occurred, indeed appears minimal. Complete logbook data after 1993 are not available.

**Table 1.** Summary of incidental mortality of northern fur seals (San Miguel Island stock) due to commercial fisheries from 1990 through 1995 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from logbook reports. n/a indicates that data are not available.

| Fishery name | Years | Data type | Range of observer coverage | Reported mortality (in given yrs.) | Estimated mortality (in given yrs.) | Mean annual mortality |
|---|---|---|---|---|---|---|
| CA/OR thresher shark and swordfish drift gillnet | 90-95 | obs data | 4-18% | 0, 0, 0, 0, 0, 0 | 0, 0, 0, 0, 0, 0 | 0 |
| CA angel shark/halibut set gillnet | 90-94 | obs data | 5-15% | 0, 0, 0, 0, 0 | 0, 0, 0, 0, 0 | 0 |
| WA/OR/CA groundfish trawl (Pacific whiting component) | 90-95 | obs data | 44-72% | 0, 0, 0, 0, 0, 0 | 0, 0, 0, 0, 0, 0 | 0 |
| Observer program total | 90-95 | | | | | 0 |
| CA/OR thresher shark and swordfish drift gillnet | 90-93 | logbook | n/a | 1, 0, 0, 0 | n/a | - |
| CA angel shark/halibut set gillnet | 90-93 | logbook | n/a | 1, 0, 1, 0 | n/a | - |
| Minimum total annual mortality | | | | | Total | 0 |

## STATUS OF STOCK

The San Miguel Island northern fur seal stock is not listed as “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 (216). 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 (22) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The stock size has increased in recent years although the population status of this stock relative to OSP 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). At present, their pelagic distribution and behavior (and any seasonal or temporal variation therein) can not be reliably 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 currently under investigation (Kretzmann et al., in press).

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 1996, identification efforts were conducted on a daily basis during three- to five-month studies at all main reproductive sites except Midway Atoll, where the study period was limited to five weeks. A total of 1238 seals (including pups) were observed at the main reproductive populations in 1996 (NMFS, unpubl. data). Removal analyses 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 studies were last conducted in 1993. Those 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. 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 1996 is unknown. In addition, the number of seals that occur naturally in the main Islands is also unknown. A best guess for abundance in the main Islands (including the seals released in 1994) is 40 animals.

### 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., 1238 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, ±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 1366 seals.

**Current Population Trend**

Between 1958 and 1996, the total of mean beach counts at the main reproductive populations declined by 60%. From 1985 to 1996, the rate of decline was ca. 4% $yr^{-1}$ (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).

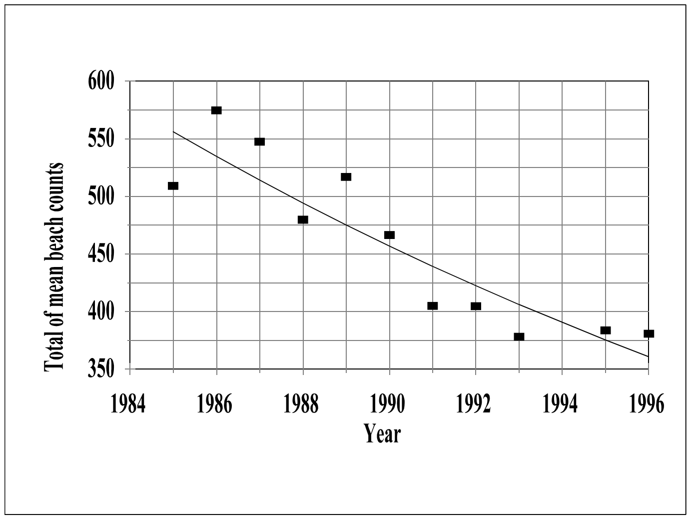


**Figure 1**. Total of mean beach counts at the main reproductive populations (excluding Midway) of the Hawaiian monk seal, 1985-96.

## 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 $yr^{-1}$ (loglinear regression of beach counts, 1985-96; $R^2 = 0.83$, $P<0.001$). Again, this trend is largely due to a catastrophic decline at French Frigate Shoals, where beach counts have decreased by 56% since 1989. In addition, populations at Laysan and Lisianski Islands continue to decline slowly.

Contrary to the decline at the above sites, the population at Kure Atoll has grown at ca. 5% $yr^{-1}$ since 1983 (loglinear regression of beach counts, 1983-96; $R^2 = 0.69$, $P<0.001$), due largely to decreased human disturbance and introduced females. And the population at Pearl and Hermes Reef has grown at approximately 7% $yr^{-1}$ since 1975 (loglinear regression of beach counts, 1975-1996; $R^2 = 0.89$, $P<0.001$). This 7% annual growth rate is the best indicator of the maximum net productivity rate ($R_{max}$) for this species.

## POTENTIAL BIOLOGICAL REMOVAL

Using the values of $N_{min}$ and $R_{max}$ given above (1366 and 0.07 $yr^{-1}$, respectively) and a recovery factor ($F_R$) of 0.1 (the Hawaiian monk seal was designated as both endangered and depleted in 1976), the potential biological removal (PBR) for this species is calculated as 1366 * (0.07 * (0.5)) * 0.1 = 4.8 seals. However, the Endangered Species Act takes precedence in the management of this species and, under the Act, allowable take is zero.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Human-related mortality has caused two major declines of the Hawaiian monk seal, and may continue to be an important factor impeding its recovery. 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, will be vacated in June, 1997. Jurisdiction of Midway Atoll is being transferred to the U.S. Fish and Wildlife Service, which will manage the atoll as a National Wildlife Refuge. The refuge station and the atoll runway will be maintained cooperatively with a commercial aircraft company, which will support its Midway operations, in part, by establishing an "ecotourism" center at the site.

Strict regulations will be 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**

Since the late 1970s, development and expansion of fisheries in the NWHI has lead to interactions detrimental to monk seals. The interactions fall into four categories: operations/gear conflict, entanglement in fisheries debris (which could have originated from other fisheries in the North Pacific), seal consumption of potentially toxic discard, and competition for prey. Since 1982, a total of six fishery-related monk seal deaths have been recorded, including three from entanglement in fisheries debris (Henderson 1990), 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 other seals have been observed with embedded fish hooks, 23 seals have been observed with uncharacteristic wounds attributed to interactions, and 138 seals have been observed entangled in fisheries or other debris. Importantly, the majority of these deaths and injuries have been observed incidentally during land-based research or other activities; monk seal/fisheries interactions have not been adequately studied and the rate of fisheries-related injury or mortality for this species can not be reliably characterized.

The Hawaiian monk seal interacts with four fisheries. 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 in 1993 due to low spawning stock biomass. Landings totalled 131,000 in 1994, dropped to 38,000 in 1995 (the fishery was open on an experimental basis only), and then increased to 186,000 in 1996 (DiNardo pers. comm.). Catch per unit effort (lobsters per trap haul) declined from 2.75 to 0.56 between 1983 and 1991, increased slightly to 0.59 in 1992, and increased again to 0.78 in 1994 (Haight and DiNardo 1995). The number of vessels in the fishery increased from four in 1983 to 16 in 1985-86, then declined to 9, 12, 0, 5, 1, and 5 in in 1991 through 1996, respectively (Dollar 1995, DiNardo, pers. comm.). 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). Seasonal and area differences in fisheries interactions, and total incidental mortality/serious injury, have not been evaluated. As just 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, indirect mortality due to competition for prey may be a more serious problem than direct interactions (see Habitat Issues below).

Monk seals also interact with the NWHI bottomfish fishery. This fishery occurred at low levels (< 50 t per year) until 1977, steadily increased to 460 t in 1987, and then dropped to ca. 140 to 190 t per year from 1988 to 1994 (Kawamoto 1995). The number of vessels rose from 19 in 1984 to 28 in 1987, and then varied from 10 to 17 in 1988 through 1995 (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 discard 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 and unstudied.

The third fishery with which monk seals interact 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). Entry is currently limited to a maximum of 167 vessels, and 124 vessels were active in 1994 (Ito 1995). 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, and the hook appeared to be from the swordfish fishery. At present, interactions with protected species are assessed using Federal logbooks and observers (4-5% coverage), which lack sufficient reliability or statistical power to estimate monk seal mortality/serious injury rates from longline interactions.

Finally, monk seals have interacted with recreational fisheries 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 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.

**Fishery Mortality Rate**

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 minimum level of interactions, not the true level. Without further study, the true level of interaction cannot be estimated. In addition, the most serious interactions may be indirect (i.e., involving competition for prey with the lobster fishery or consumption of discard from the bottomfish fishery) and, to date, the extent or consequences of such indirect interactions have not been evaluated.

Table 1. Summary of incidental mortality of Hawaiian monk seals due to commercial and recreational fisheries from 1990 to 1995 and calculation of annual mortality rate. n/a indicates that 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 | 91-96 | 9, 12, 0, 5, 1,5 | log book | n/a | n/a | n/a | n/a |
| NWHI Bottomfish | 91-95 | 17, 13, 12, 16, 17 | n/a | n/a | n/a | n/a | n/a |
| Pelagic longline | 91-95 | 141, 123, 122, 125, 110 | observer log book | 4-5% | n/a | 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.

**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 a 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 seals have 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 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 seal is thought to have died from mobbing at this site in 1995-96. Such imbalances in the adult sex ratio are more likely to occur when populations are reduced (Starfield et al. 1995). To the extent that human activity has reduced monk seal populations, such activity may have contributed to the mobbing problem.

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 probably not the primary cause of the recent decline at this site (Ragen 1993). The annual rate and number of shark-related mortalities is being investigated. 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. In the NWHI, the danger of ciguatera poisoning is considered to be greatest at Midway Atoll (Hokama, University of Hawaii, pers. comm.), where nearshore construction and the reshaping of Sand Island may contribute to the probability of dinoflagellate blooms. 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 OSP and, since 1985, has declined at 4-5% per year. Therefore, the Hawaiian monk seal is characterized as a strategic stock. As noted above, the total fishery mortality and serious injury for this stock is greater than 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.

**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). Thus, this population may have significantly overshot 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 eat lobster and forage at the four main banks where the fishery operates: Maro Reef, Gardiner Pinnacles, St. Rogatien Bank, and Necker Island. This information suggests that competition for prey is a reasonable hypothesis that merits investigation. This potential for competition cannot yet be evaluated because we do not know the importance of lobster as a component of the monk seal diet.

A second important habitat issue is the management of human activities at Midway Atoll. Historically, such activities have led to the near extinction of the resident monk seal population 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. At the same time, management jurisdiction of Midway Atoll is being transferred from the U.S. Navy to the Fish and Wildlife Service, which should lead to a substantial reduction in human activities that disturb monk seals. The Fish and Wildlife Service and NMFS are working cooperatively to ensure that human activities do not impede recovery at this important site.

The Fish and Wildlife Service will maintain a refuge station at the site by cooperating with a commercial aircraft company that will use the runway on Sand Island (the largest island at Midway Atoll), and will support its operations, in part, by establishing an on-site eco-tourism destination. Projected 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.

A third important habitat issue is the decaying 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. Decay of the seawall is creating entrapment hazards for seals and other wildlife, and 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. Marine debris is removed from the beaches and entangled seals during annual population assessment activities at the main reproductive sites. Little effort, however, has been devoted to the removal of potentially entangling marine debris from the reefs surrounding haulout sites utilized by monk seal. The continued accumulation of this debris may pose a serious threat to seals foraging in these waters. To date, no systematic efforts have been made to assess or remove this debris.

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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 AMOVA analysis of the same data with additional samples found significant genetic differences for 4 of the 6 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 pan-mictic or migratory, and movement is sufficiently restricted that genetic differences have evolved.

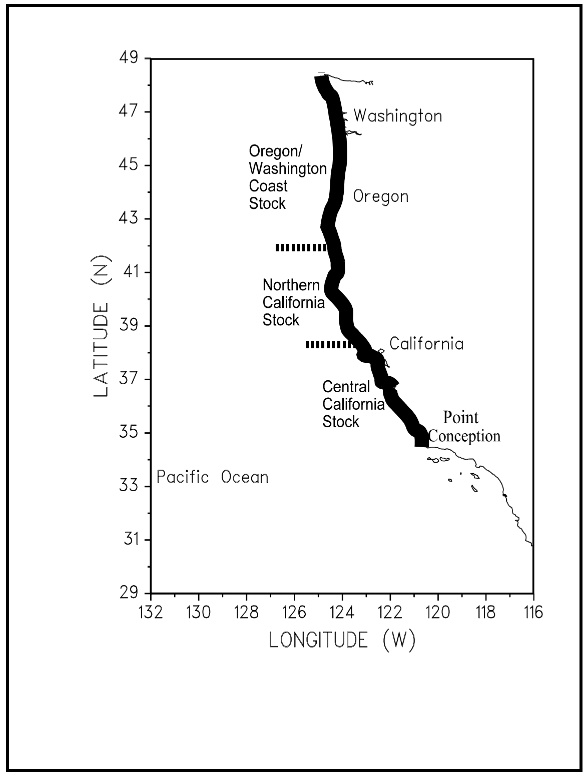


**Figure 1**. Stock boundaries and distributional range of harbor porpoise along the U.S. west coast.

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. Other Pacific coast Marine Mammal Protection Act (MMPA) stock assessment reports for harbor porpoise include: 1) a northern California stock 2) an Oregon/Washington coastal stock, 3) a Washington inland-waters stock, 4) a Southeast Alaska stock, 5) a Gulf of Alaska stock, and 6) a Bering Sea stock.

## POPULATION SIZE

Barlow and Forney (1994) reviewed previous estimates of harbor porpoise abundance in central California and presented a new estimate of 4,120 (CV=0.22) based on a series of aerial surveys from 1988 to 1993 (corrected for submerged animals that are missed). This recent estimate is not significantly different from the previous estimate of 3,274 (CV=0.31) based on ship surveys but is more precise (owing to the greater number of kilometers surveyed). 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.

**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 abundance estimated from the 1988-93 aerial surveys (Barlow and Forney 1994) or 3,431.

**Current Population Trend**

An analysis of a 1986-95 time series of aerial surveys was conducted to examine trends in harbor porpoise abundance in central California ( Forney 1996). After controlling for the effects of sea state, cloud cover, and area on sighting rates, Forney (1996) found a negative trend in populations size, but that trend was not statistically significant (p=0.15) (Fig. 2). Indications of a decline were most evident in the southern part of central California, between Point Conception and Monterey Bay. A real population decline would be somewhat surprising given that fishery mortality has been declining during this same time period (Table 1). Harbor porpoise abundance appears to be correlated with changes in sea surface temperature (Forney 1996), and apparent trends could be caused by changing oceanographic conditions.

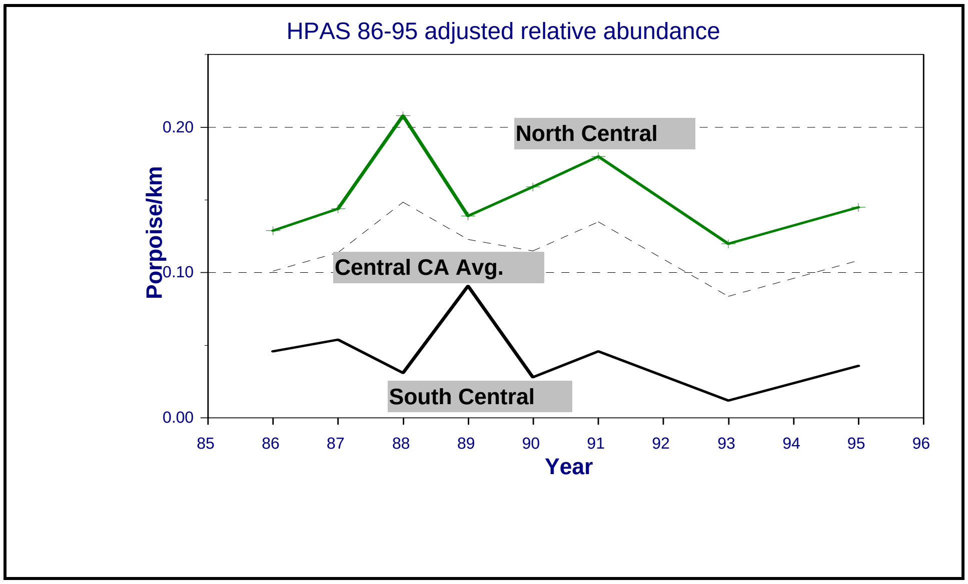


**Figure 2**. Harbor porpoise relative abundance in central California from aerial surveys (corrected for effects of sea state and cloud cover, Forney 1996).

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (ie. 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). [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.] This maximum theoretical rate may not be achievable for any real population. 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.

## POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (3,431) times one half the default maximum net growth rate for cetaceans (1/2 of 4%) times a recovery factor of 0.48 (for a species of unknown status with a mortality rate CV=0.44), resulting in a PBR of 33.

## ANNUAL HUMAN-CAUSED MORTALITY

### Fishery Information

The incidental capture of harbor porpoise is largely limited to set gillnet fisheries in central California (coastal setnets are not allowed in northern California, and harbor porpoise do not occur in southern California). A summary of known fishery mortality and injury for this stock of harbor porpoise is given in Table 1. Detailed information on this fishery is provided in Appendix 1. The average fishery mortality for the central California stock is estimated to be 14 harbor porpoise per year for the three most recent years of monitoring (1993-95) (note that a 3-year average is appropriate for this stock because fishing effort declined dramatically in 1993). In general, total fishery mortality has gone down due to a reduction in fishing effort and changes in the geographic distribution of sets.

**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 and Beeson, in press). 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 1993-95 (CV in parentheses) |
|---|---|---|---|---|---|---|
| **CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery** | 1991<br>1992<br>1993<br>1994<br>1995 | NMFS observer data | 9.8%<br>12.5%<br>15.4%<br>7.7%<br>0.0% | 5<br>6<br>2<br>1<br>- | 38 (0.47)<br>48 (0.46)<br>13 (0.64)<br>14 (0.96)<br>14 (0.64) [1] | 14 (0.44) [2] |
| **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 |
| **Total annual takes** | | | | | | 14 (0.44) |

[1] The CA set gillnets were not observed after 1994; mortality was extrapolated from effort estimates and previous entanglement rates.
[2] Set gillnet fishing effort declined in 1993-95 (Appendix 1); consequently, California set gillnet mortality was averaged for those years only.

## 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 mortality rate over the last 3 years (14) is less than the calculated PBR (33) 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 is declining and may be listed as threatened under the Endangered Species Act unless the decline is stopped. Because fishery mortality has declined over the last 10 years and 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. Research activities will continue to monitor the population size and to investigate the causes of the possible decline. The average gillnet mortality for the last 3 years (14 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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# 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 AMOVA analysis of the same data with additional samples found significant genetic differences for 4 of the 6 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 pan-mictic or migratory, and movement is sufficiently restricted that genetic differences have evolved.

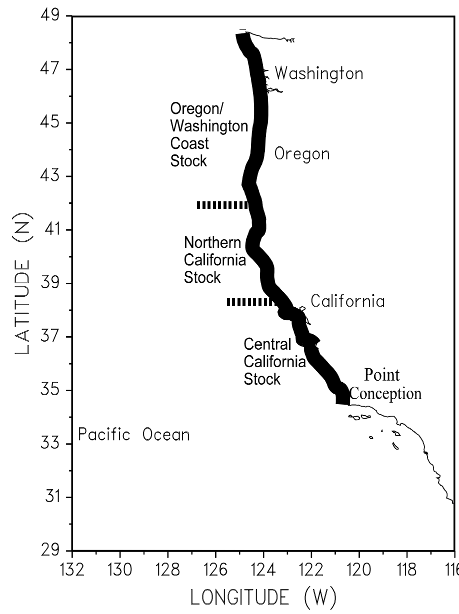


**Figure 1**. Stock boundaries and distributional range of harbor porpoise along the U.S. west coast.

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. Other Pacific coast Marine Mammal Protection Act (MMPA) stock assessment reports for harbor porpoise include: 1) a central California stock 2) an Oregon/Washington coastal stock, 3) a Washington inland-waters stock, 4) a Southeast Alaska stock, 5) a Gulf of Alaska stock, and 6) a Bering Sea stock.

## POPULATION SIZE

Barlow and Forney (1994) reviewed previous estimates of harbor porpoise abundance in northern California and presented a new estimate of 9,250 (CV=0.23) based on a series of aerial surveys from 1989 to 1993 (corrected for submerged animals that are missed). This estimate only includes 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.

### 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 abundance estimated from the 1988-93 aerial surveys (Barlow and Forney 1994) or 7,640.

**Current Population Trend**

Forney (1996) 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.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (ie. 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). [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.] This maximum theoretical rate may not be achievable for any real population. 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.

## POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (7,640) times one half the default maximum net growth rate for cetaceans (1/2 of 4%) times a recovery factor of 0.5 (for a species of unknown status), resulting in a PBR of 76.

## ANNUAL 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).

**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.

## 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. 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 known human-caused mortality or serious injury, this would not be considered a "strategic" stock under the MMPA. There are no known habitat issues that are of particular concern for this stock.

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

## STOCK DEFINITION AND GEOGRAPHIC RANGE

In the eastern North Pacific Ocean, the harbor porpoise ranges from Point Barrow, along the Alaskan coast, and down the west coast of North America to Point Conception, California (Gaskin 1984). Harbor porpoises primarily frequent coastal waters. Harbor porpoises are known to occur year-around 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 (Barlow 1988, Dohl et al. 1983), 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.

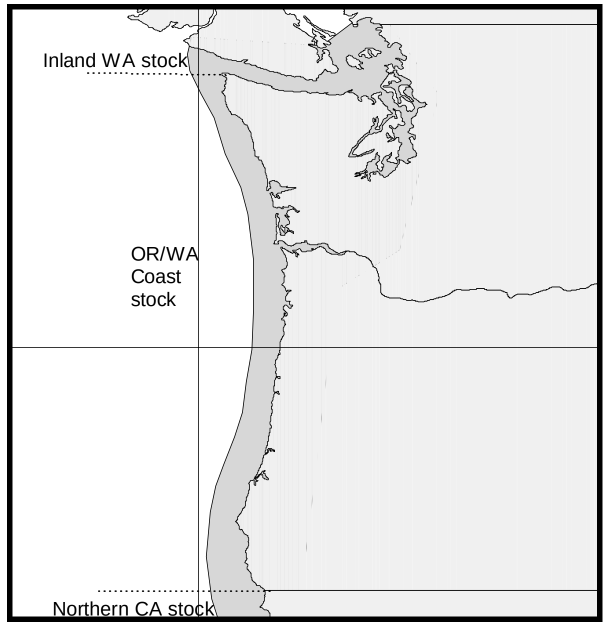


**Figure 1.** Approximate distribution of harbor porpoise in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the stocks are shown.

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 4 of the 6 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 specimen 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. (1993b) for water depths < 50 fathoms, Osmek et al. (in prep.) 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 1940's, 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. In the future, biological evidence for delineating stocks may come from the analysis of environmental pollutants in tissues, from seasonal movements of individual harbor porpoises, or new genetic analytical methods.

In their assessment of California harbor porpoise, Barlow and Hanan (1995) recommended 2 stocks be recognized in California, with the stock boundary at the Russian River. The justifications given were 1) fishery mortality in California is limited to central California (south of the Russian River), 2) movement of individuals appears to be restricted within California, and consequently 3) fishery mortality could cause local depletion of harbor porpoise if central California is not managed separately. Based on the above information 4 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.

## POPULATION SIZE

Aerial surveys of the Washington coast, and parts of the southwest Strait of Juan de Fuca, were conducted during summer 1990 (Calambokidis et al. 1991) by flying a saw-tooth design at an altitude of 183 m (600 feet), and speeds of 185 km/hr (100 knots), from shore out to the 50 fathom isobath. During 1991, surveys using the same 1990 methodology, were flown over the marine waters of coastal Oregon and Washington, as well as inland waters of Washington (Calambokidis et al. 1992). Because the 1990-91 surveys both covered coastal Washington and portions of the western Strait of Juan de Fuca, these data were pooled and used to calculate abundance estimates (Calambokidis et al. 1993b) following the methods described by Buckland et al. (1993). Only effort and sightings made during excellent sighting conditions (Beaufort levels of 2 or less and cloud cover of less than 25%) were used. A single estimate of f(0) and of group size was calculated using data from all regions in both years. The correction factor [1/g(0)] of 3.1 and its associated variance (g(0)=0.324, var=0.003) was used to adjust the 1990-91 harbor porpoise sighting data for groups missed by aerial observers (Calambokidis et al. 1993a). The best corrected estimate of abundance for harbor porpoises in coastal Oregon and Washington waters is 26,175 (CV=0.206). This estimate includes animals along the US/Canadian boundary waters and a portion of the southern coastal waters of British Columbia along the Strait of Juan de Fuca.

### 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 26,175 and its associated CV of 0.206, $N_{MIN}$ for the Oregon/Washington coast stock of harbor porpoise is 22,046.

### Current Population Trend

There are no reliable data on population trends of harbor porpoises 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 porpoises. 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 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 0.48, the value for a cetacean stock with an unknown population status and with a CV of mortality estimates between 0.3 and 0.6 (Wade and Angliss 1997). Thus, for Oregon/Washington coast stock of harbor porpoise, PBR = 212 animals (22,046 x 0.02 x 0.48).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

Within the EEZ boundaries of coastal Oregon and Washington, human-caused (fishery) mortalities of harbor porpoises are presently known to occur only in the northern Washington marine set gillnet fishery. During 1991-93 the WA/OR Lower Columbia River, WA Grays Harbor, and WA Willapa Bay drift gillnet fisheries were monitored at observer coverages of approximately 12%, 4% and 2%, respectively. There were no observed harbor porpoise mortalities in these fisheries.

With the exception of 1994, NMFS observers recorded harbor porpoise mortality incidental to the northern Washington marine set gillnet fishery during 1990-1995 (Gearin et al. 1994; P. Gearin, unpubl. data). For the entire area fished, observer coverage ranged from approximately 47-87% 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). Data from 1990-1995 are included in the Table 1, although the mean estimated annual mortality is calculated using only the most recent 3 years of data (1991, 1992 and 1995). No fishing effort occurred in the coastal portion of the fishery in 1993 and, as noted above, no observer program occurred in 1994. The mean estimated mortality from 1991-95 for this fishery is 12.7 (CV=0.50) harbor porpoises per year from this stock.

The 1995 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. Preliminary results indicate that acoustic alarms may indeed aid in reducing harbor porpoise mortalities as only 1 of the 20 porpoise taken during the fishery was taken in an alarmed net (Gearin et al. 1996). Results of the 1996 continuation of this study are not yet available.

An additional source of information on the number of harbor porpoises killed or injured incidental to commercial fishery operations is the logbook reports maintained by vessel operators as required by the MMPA interim exemption program. During the 4-year period between 1990 and 1993 there were no logbook reports of harbor porpoise mortalities from any fisheries operating within the range of the Oregon/Washington coast stock. However, because logbook records are most likely negatively biased (Credle et al. 1994), this is considered to be a minimum estimate. Complete logbook data after 1993 are not available.

**Table 1.** Summary of incidental mortality of harbor porpoises (Oregon and Washington coast stock) due to commercial fisheries from 1990 through 1995 and calculation of the mean annual mortality rate. n/a indicates that data are not available.

| **Fishery name** | **Years** | **Data type** | **Range of observer coverage** | **Observed mortality (in given yrs.)** | **Estimated mortality (in given yrs.)** | **Mean annual mortality** |
|---|---|---|---|---|---|---|
| Northern WA marine set gillnet | 90-95 | obs data | 68-100% | 13, 13, 0, n/a, n/a, 20 | 16, 18, 0, n/a, n/a, 20 | 12.7 (CV=0.5) |
| Observer program total | | | | | | 12.7 |
| Estimated total annual mortality | | | | | | 12.7 (CV=0.5) |

## 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 (13) does not exceed the PBR (212). Therefore, the Oregon/Washington coast stock of harbor porpoise is not classified as strategic. The total fishery mortality and serious injury for this stock (13; based on observer data) is not known to exceed 10% of the calculated PBR (21) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The status of this stock relative to OSP and population trends are unknown.

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Revised 8/1/97

# 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 porpoises are known to occur year-around 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 (Barlow 1988, Dohl et al. 1983), 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.

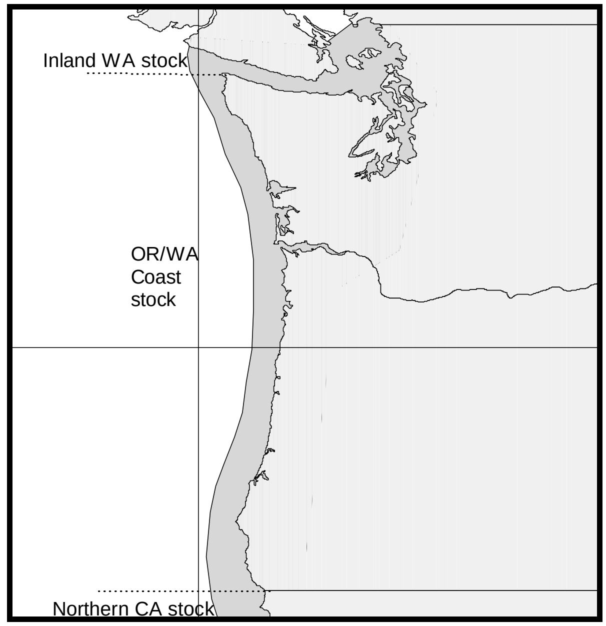


**Figure 1.** Approximate distribution of harbor porpoise in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the stocks are shown.

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 porpoises 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 4 of the 6 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 specimen from the North Atlantic, where numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles.

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## POPULATION SIZE

Aerial surveys of the Washington coast, and parts of the southwest Strait of Juan de Fuca, were conducted during summer 1990 (Calambokidis et al. 1991) by flying a saw-tooth design at an altitude of 183 m (600 feet), and speeds of 185 km/hr (100 knots), from shore out to the 50 fathom isobath. During 1991, surveys using the same 1990 methodology, were flown over the marine waters of coastal Oregon and coastal/inland Washington (Calambokidis et al. 1992). Survey track-lines, within inland Washington, were flown from shore to shore covering all depth contours. Because the 1990-91 surveys both covered coastal Washington and portions of the western Strait of Juan de Fuca, these data were pooled and used to calculate abundance estimates (Calambokidis et al. 1993b) following the methods described by Buckland et al. (1993). Only effort and sightings made during excellent sighting conditions (Beaufort levels of 2 or less and cloud cover of less than 25%) were used. A single estimate of f(0) and of group size was calculated using data from all regions in both years. The correction factor [1/g(0)] of 3.1 and its associated variance (g(0)=0.324, var=0.003) was used to adjust the 1990-91 harbor porpoise sighting data for groups missed by aerial observers (Calambokidis et al. 1993a). The best corrected estimate of abundance for harbor porpoises of inland Washington waters is 3,352 (CV=0.270). This estimate includes animals along the northern Strait of Juan de Fuca (Canadian waters) and the US/Canadian boundary waters of the San Juan Islands and the adjacent waters of southern British Columbia.

An aerial survey covering the inland waters of Washington and British Columbia was completed in August of 1996. Results from this survey (available in 1997) will be stratified to allow the number of harbor porpoise in both U. S. and southern British Columbia waters to be estimated.

### 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 3,352 and its associated CV of 0.270, $N_{MIN}$ for the Inland Washington stock of harbor porpoise is 2,681.

### Current Population Trend

There are no reliable data on population trends of harbor porpoises for most waters of Oregon, Washington or British Columbia. In southern Puget Sound, however, harbor porpoises are now rarely observed, a sharp contrast to 1942 when harbor porpoises 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 1970's (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 porpoises. 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 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 = $N_{MIN}$ x $0.5R_{MAX}$ x $F_R$. 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 Inland Washington stock of harbor porpoise, PBR = 21 animals (2,681 x 0.02 x 0.4).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

With the exception of 1994, NMFS observers have recorded harbor porpoise mortality incidental to the northern Washington marine set gillnet fishery during 1990-1995 (Gearin et al. 1994; P. Gearin, unpubl. data). For the entire area fished, observer coverage ranged from approximately 47-87% 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). Data from 1990-95 are included in the Table 1, although the mean estimated annual mortality is calculated using only the most recent 3 years of data (1992, 1993, and 1995). As noted above, there was no observer program in 1994. Little effort occurred in the inland portion of the fishery in 1995, the observer coverage was lower than usual (24%), and no mortalities were observed. The mean estimated mortality from 1992-1995 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, the NMFS in conjunction with the Washington Department of Fish and Wildlife (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.

Combining the estimates from the 1994 observer programs (15) with the northern Washington marine set gillnet fishery (which has not taken a harbor porpoise since 1991) 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 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 fisheries from 1990 through 1995 and calculation of the mean annual mortality rate. n/a indicates that data are not available.

| Fishery name | Years | Data type | Range of observer coverage | Observed mortality (in given yrs.) | Estimated mortality (in given yrs.) | Mean annual mortality |
|---|---|---|---|---|---|---|
| Northern WA marine set gillnet | 90-95 | obs data | 24-74% | 0, 1, 0, 0, n/a, 0 | 0, 2, 0, 0, n/a, 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 (CV=1.0) |
| Observer program total | | | | | | 15 |
| | | | | **Reported mortalities** | | |
| WA Puget Sound Region salmon set/drift gillnet | 90-93 | logbook | n/a | 6, 4, 6, 2 | n/a | see text |
| Minimum total annual mortality | | | | | | $15 (CV=1.0) |

An additional source of information on the number of harbor porpoise killed or injured incidental to commercial fishery operations is the logbook reports maintained by vessel operators as required by the MMPA interim exemption program. Logbook reports from 1990-93 for the Washington Puget Sound Region salmon set and drift gillnet fishery are shown in Table 1. Unlike the 1994 observer program data, the logbook data cover the entire fishery. However, as logbook records are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates of harbor porpoise mortality. Complete logbook data after 1993 are not available. Though the 1994 observer program data may underestimate the total fishery mortality for this stock, it is considered more reliable than the logbook data. Thus, the logbook data were not used in the mortality rate calculation.

There are few data concerning the mortality of marine mammals incidental to commercial gillnet fisheries in

Canadian waters, which have taken harbor porpoise in the past (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.

A conservative approach seems appropriate when managing the Inland Washington harbor porpoise stock because: 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) this is a trans-boundary stock with a minimum population estimate and a PBR that is based on some portion of the harbor porpoises that occupy British Columbia waters but were within the 1991 aerial survey area (see "Population Estimates", Calambokidis et al. 1993b), 3) the mortality rate is based on observer data from a subset of the Washington Puget Sound Region salmon set and gillnet fishery, and 4) the mortality rate does not account for animals taken by fisheries in the inland waters of southern British Columbia, where incidental mortality has not been monitored (Barlow et al. 1994).

**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 (21). 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 (2.1) and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. The status of this stock relative to OSP and population trends are unknown, although harbor porpoise sightings in the southern Puget Sound have declined in recent years. It is recommended that the status of this stock be reviewed during 1997 after the abundance estimates of the 1996 aerial surveys are available.

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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; Forney et al. 1995; Barlow 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.

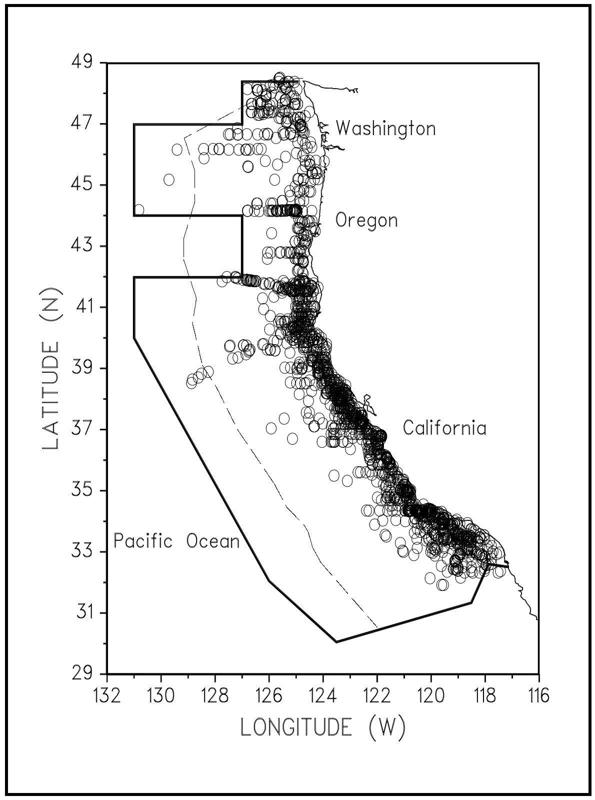


**Figure 1.** Dall's porpoise sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys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

## POPULATION SIZE

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 (C.V. = 0.40) Dall's porpoise.

### Minimum Population Estimate

The log-normal 20th percentile of the above abundance estimate is 34,393 Dall's porpoise.

### Current Population Trend

No information is available regarding trends in abundance of Dall's porpoise in California, Oregon and Washington.

## 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. ½$R_{max}$ 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.

**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.

**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.

| 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** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 2<br>1<br>9<br>2<br>1 | 20 (0.67)<br>7 (0.92)<br>67 (0.44)<br>11 (0.64)<br>6 (0.92) | 22 (0.52) |
| **WA/OR/CA domestic groundfish trawl fisheries** | observer data | 1991<br>1992<br>1993<br>1994<br>1995<br>1996 | 53.9%<br>72.6%<br>65.8%<br>53.8%<br>56.2%<br>66.0% | 0<br>1<br>0<br>0<br>0<br>0 | 0<br>1 (0.52)<br>0<br>0<br>0<br>0 | |
| | other reports | 1994<br>1996 | | 2<br>1 | n/a | 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) |

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). The average estimated annual mortality for Dall's porpoise in this fishery in 1991-95 is

22 (CV=0.52) animals.

Similar 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 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.

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 and 1996, four Dall's porpoise were reported killed in these fisheries during 2993 observed fishing days, 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 mortality was estimated to be about one porpoise in 1992 (CV=0.52; Perez, in prep). 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 1.

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).

**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. Because the average annual human-caused mortality in 1991-95 (22 animals) is estimated to be less than the PBR (330), 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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Revised 08/01/97

# 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; 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).

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 33ºN, (Southern California to Alaska), and southern specimens were obtained from about 36ºN 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). 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).

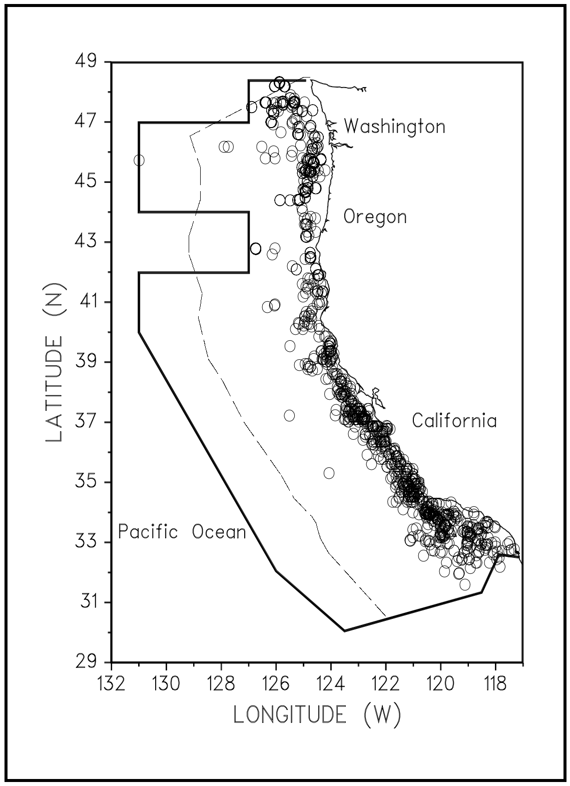


**Figure 1**. Pacific white-sided dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary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

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 (C.V. = 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.

**Minimum Population Estimate**

The log-normal 20th percentile of the above abundance estimate is 82,939 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. ½$R_{max}$ 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.

## 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). The average estimated annual mortality for Pacific white-sided dolphins in this fishery in 1991-95 is 22 (CV=0.34) animals.

Similar 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 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.

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 and 1996, three Pacific white-sided dolphins were reported killed in these fisheries during 2993 observed fishing days, 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.

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).

**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.

| 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** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 5<br>3<br>2<br>3<br>1 | 51 (0.63)<br>22 (0.70)<br>15 (0.66)<br>17 (0.67)<br>6 (0.92) | 22 (0.34) |
| **WA/OR/CA domestic groundfish trawl fisheries** | observer data | 1991<br>1992<br>1993<br>1994<br>1995<br>1996 | 53.9%<br>72.6%<br>65.8%<br>53.8%<br>56.2%<br>66.0% | 0<br>0<br>0<br>0<br>0<br>0 | 0<br>0<br>0<br>0<br>0<br>0 | |
| | other records | 1996 | | 3 | n/a | 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) |

**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) 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). 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

# 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.

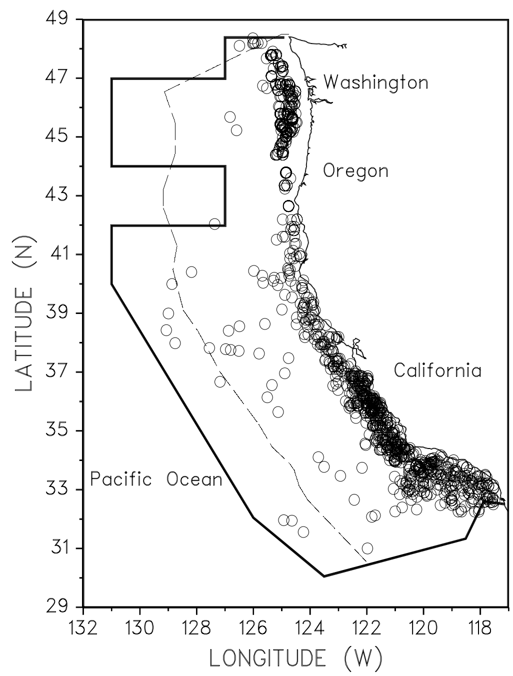


**Figure 1.** Risso's dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys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

## POPULATION SIZE

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 (C.V. = 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.

### Minimum Population Estimate

The log-normal 20th percentile of the above abundance estimate is 22,388 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.

## 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. ½$R_{max}$ 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.

## 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). The average estimated annual mortality for Risso's dolphins in this fishery in 1991-95, is 37 (CV=0.22) animals.

**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.

| 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** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 5<br>5<br>7<br>1<br>6 | 51 (0.50)<br>37 (0.48)<br>52 (0.51)<br>6 (0.91)<br>39 (0.57) | 37 (0.22) |
| **CA squid purse seine fishery** | strandings | 1988-89 | | 4 | n/a | n/a |
| **OR experimental thresher shark gillnet fishery** | observer data | 1986-88 | 10.3% | 4 | approx. 13 | 0<br>(Fishery discontinued) |
| **Minimum total annual takes 1991-95** | | | | | | 37 (0.22) |

Similar 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 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.

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).

**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. 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.

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Revised 08/01/97

# BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California Coastal 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). California coastal bottlenose dolphins are found within about one kilometer of shore (Figure 1; Hansen 1990; NMFS, unpublished data) primarily from Point Conception south into Mexican waters, at least as far south as Ensenada. 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), and monthly counts based on surveys between the U.S./Mexican border and Point Conception are variable Carretta et al., in prep.), 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.

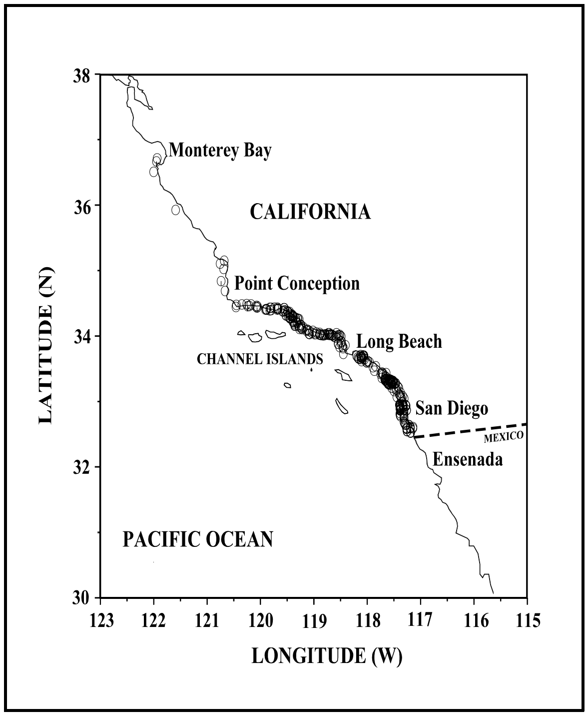


**Figure 1.** Coastal bottlenose dolphin sightings based on aerial surveys along the coast of California in 1990-94 (see Appendix 2 for data sources and information on timing and location of survey effort). This population of bottlenose dolphins is found within about 1km of shore.

## POPULATION SIZE

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 (C.V. = 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). 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. 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.

### Minimum Population Estimate

The log-normal 20$^{th}$ percentile of the above average abundance estimate for U.S. waters (Carretta et al., in prep) is 134 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 ½$R_{max}$ 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.

## 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 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. 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. 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 1991-95 |
|---|---|---|---|---|---|---|
| **CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery** | observer data | 1991-94 | 10-15% | 0 | none or few | 0 |
| **Undetermined** | strandings | 1975-90 | 4 bottlenose dolphins of unknown stock stranded with evidence of fishery interactions | | | |
| **Minimum total annual takes 1991-95** | | | | | | 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). 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

# 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 41ºN (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. Although offshore 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, 2) California, Oregon and Washington offshore stock (this report), and 3) Hawaiian stock.

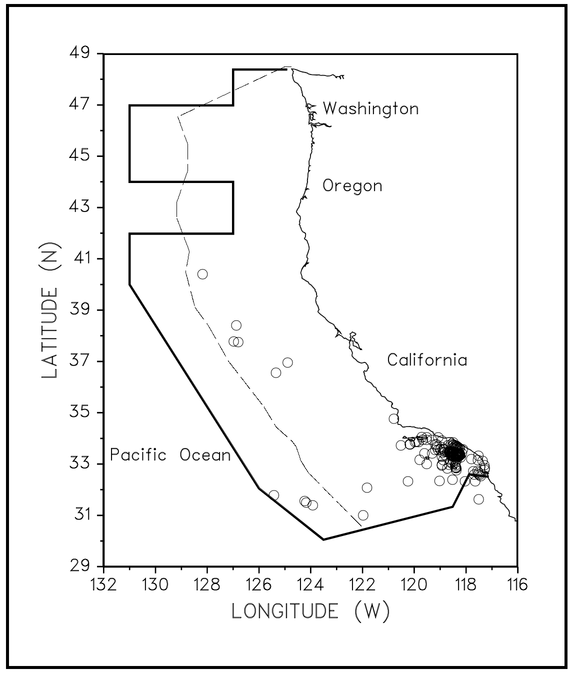


**Figure 1.** Offshore bottlenose dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of survey effort). All sightings were made at distances greater than a few kilometers from the 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 (C.V. = 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 (C.V. = 0.36) offshore bottlenose dolphins.

### 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) is 1,904 animals.

### 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. ½$R_{max}$ 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.

## 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).

**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.

| 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** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>3<br>0<br>0<br>0 | 0<br>22 (0.93)<br>0<br>0<br>0 | 4.4 (1.00) |
| **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) |

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.

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.

### 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.

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# 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.

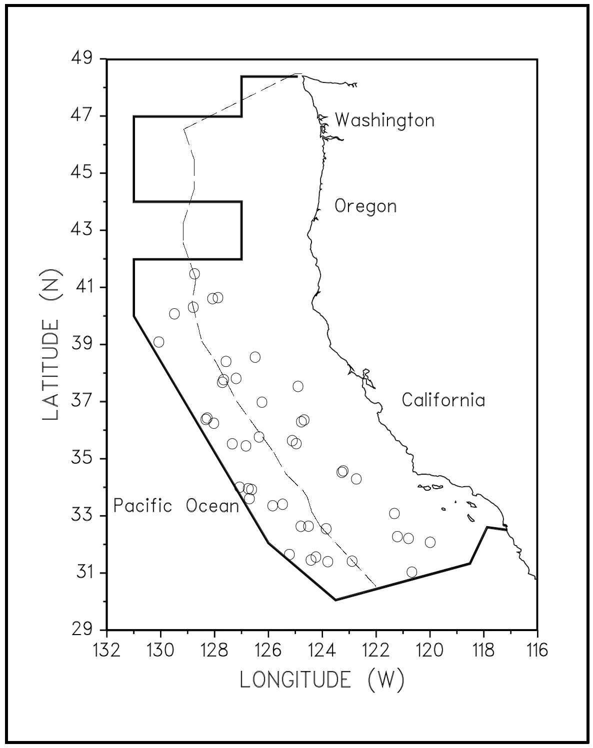


**Figure 1.** Striped dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys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

## POPULATION SIZE

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 (C.V. = 0.31).

### Minimum Population Estimate

The minimum population estimate for striped dolphins in California (defined as the log-normal 20th percentile of the above abundance estimate) is 19,248 animals.

### 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.

## 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.

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 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.

| 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** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>0<br>0<br>1<br>0 | 0<br>0<br>0<br>6 (0.90)<br>0 | 1.2 (1.00) |
| **Minimum total annual takes 1991-95** | | | | | | 1.2 (1.00) |

## 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.

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

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Short-beaked common dolphins are the most abundant cetacean off California, and are widely distributed between the coast and at least 300 nmi distance from shore. The abundance of this species off California has been shown to change on both seasonal and inter-annual time scales (Dohl et al. 1986; Barlow 1995; Forney et al. 1995). Historically, they were reported primarily south of Pt. Conception (Dohl et al. 1986), but on recent (1991/93) 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.). 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.

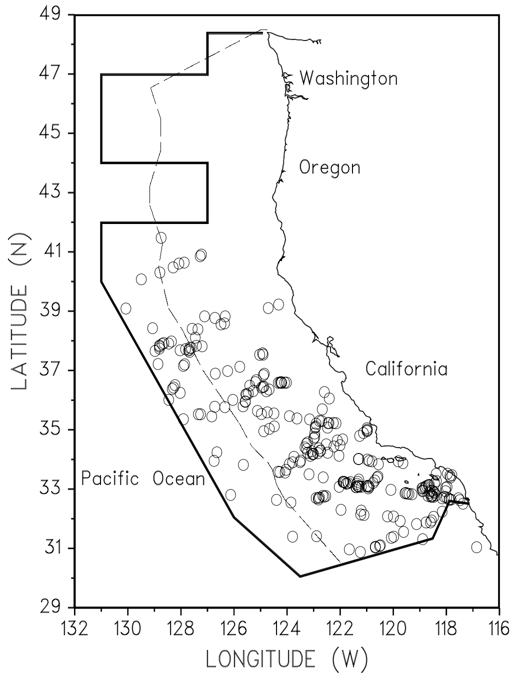


**Figure 1.** Short-beaked common dolphin sightings based on 1991 and 1993 California shipboard surveys, during which the two species of *Delphinus* were differentiated (see Appendix 2 for data sources and information on timing and location of survey effort). No *Delphinus* sightings have been made off Oregon and Washington. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

## POPULATION SIZE

Aerial line transect surveys conducted in winter/spring of 1991-92 resulted only in a combined abundance estimate of 305,694 (C.V. = 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 372,425 (C.V. = 0.22) short-beaked common dolphins (Barlow and Gerrodette 1996).

### Minimum Population Estimate

The log-normal 20th percentile of the abundance estimate from the combined 1991 and 1993 shipboard surveys is 309,717 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). A recent analysis including data from a 1993 summer survey resulted in a further increase in the abundance estimate (Barlow and Gerrodette 1996). An ongoing decline in the combined abundance of 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 (Inter-American Tropical Tuna Commission 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.

## 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. 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 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. 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.

Additional common dolphin mortality has been reported for set gillnets in California (Table 1); 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. 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).

Similar drift and set gillnet fisheries exist along the entire Pacific coast of Baja California, Mexico and probably take short-beaked common dolphins 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 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 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.

| Fishery Name | Data Type | Year | Percent Observer Coverage | Observed + Prorated Mortality | Estimated Annual Mortality, observed + prorated | Mean Annual Takes 1991-95 |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | observer data | 1991 | 9.8% | 37 + 6 | 376 (0.21) + 61 | 271 (0.19) (includes prorated and released alive) |
| | | 1992* | 13.6% | 39 + 5 | 287 (0.21) + 37 | |
| | | 1993 | 13.4% | 24 + 4 | 179 (0.26) + 30 | |
| | | 1994 | 17.9% | 25 + 1 | 140 (0.18) + 6 | |
| | | 1995 | 15.6% | 36 + 0 | 231 (0.29) + 0 | |
| | | *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 | 9.8% | 0 | 0 | |
| | | 1992 | 12.5% | 2 | 15 (0.66) | |
| | | 1993 | 15.4% | 0 | 0 | |
| | | 1994 | 7.7% | 0 | 0 | |
| | | 1995 | 0% | - | 0 | >1[1] |
| | self-reporting | 1995 | - | 1 | - | |
| **Minimum total annual takes** | | | | | | 272 (0.19) |

[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).

**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 and 1995, annual mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between 9 and 1,773 animals, with an average of 426 (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), 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. 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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# 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.

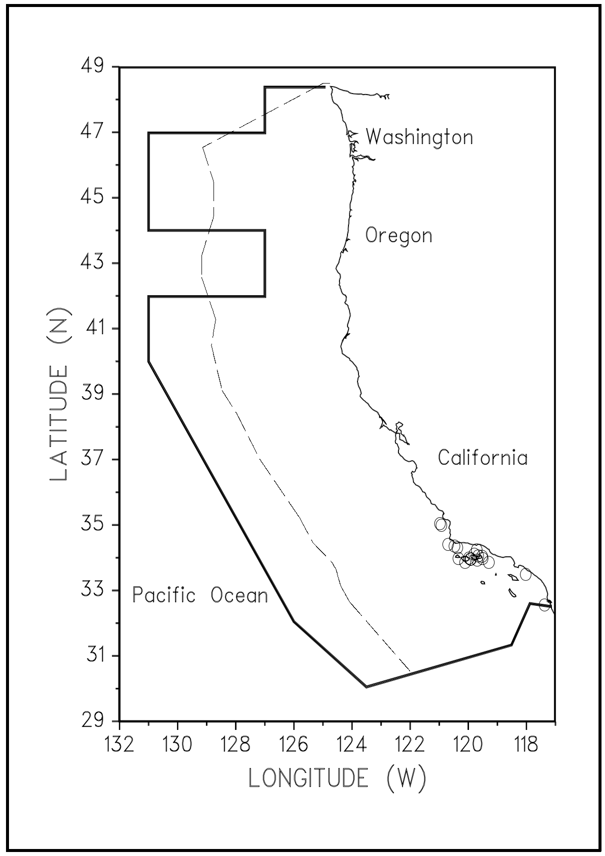


**Figure 1.** Sightings of long-beaked common dolphins based on California shipboard surveys in 1991 and 1993, during which the two species of *Delphinus* were differentiated (see Appendix 2 for data sources and information on timing and location of survey effort). No *Delphinus* sightings have been reported 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 (C.V. = 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 (C.V. = 0.64) long-beaked common dolphins (Barlow and Gerrodette 1996).

### Minimum Population Estimate

The log-normal 20th percentile of the abundance estimate from the combined 1991 and 1993 shipboard surveys is 5,504 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). An ongoing decline in the combined abundance of 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.

## 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. 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 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. 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.

Additional common dolphin mortality has been reported for set gillnets in California (Table 1); however, because of a 1994 ban on gillnets in nearshore waters of Southern California, the size of this fishery has been dramatically reduced in recent years. 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).

Similar 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 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 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.

| **Fishery Name** | **Data Type** | **Year(s)** | **Percent Observer Coverage** | **Observed+ Prorated Mortality** | **Estimated Annual Mortality, observed + prorated** | **Mean Annual Takes 1991-95** |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0 + 1<br>2 + 0<br>0 + 0<br>1 + 0<br>6 + 0 | 0 + 10<br>15 (0.92) + 0<br>0 + 0<br>6 (0.91) + 0<br>39 (0.65) + 0 | 14 (0.48) |
| **CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery** | observer data | Common dolphins, species not determined | | | | |
| | | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>12.5%<br>15.4%<br>7.7%<br>0% | 0<br>2<br>0<br>0<br>- | 0<br>15 (0.66)<br>0<br>0<br>0 | 0 [1] |
| **Minimum total annual takes** | | | | | | 14 (0.48) |

[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).

**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 and 1995, annual mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between 9 and 1,773 animals, with an average of 426 (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. The average total fishery mortality and injury for long-beaked common dolphins is greater than 10% of the 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

# 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). 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). 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.

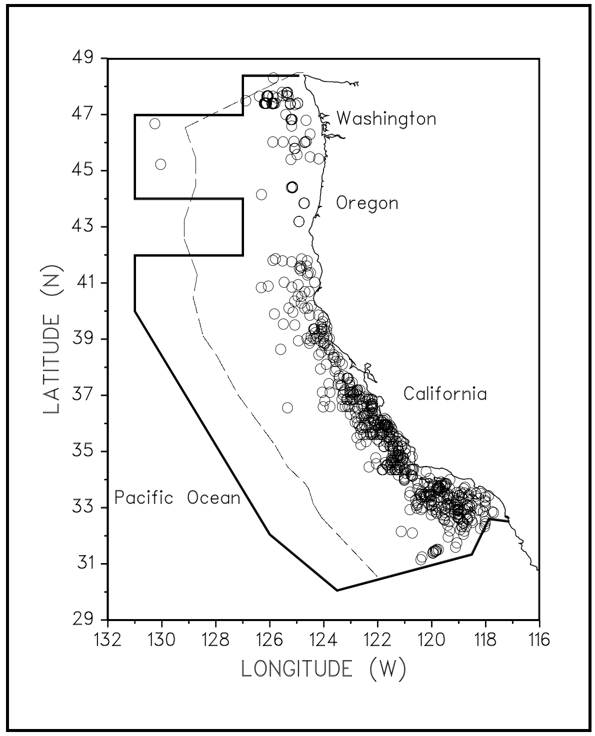


**Figure 1.** Northern right whale dolphin sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary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

## POPULATION SIZE

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 (C.V. = 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.

### Minimum Population Estimate

The log-normal 20th percentile of the above abundance estimate is 15,080 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 ½$R_{max}$ 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.

**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.

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 during cold-water periods. 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.

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).

**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.

| 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** | observer data | 1991 | 9.8% | 7 | 71 (0.41) | |
| | | 1992 | 13.6% | 2 | 15 (0.65) | |
| | | 1993 | 13.4% | 7 | 52 (0.39) | |
| | | 1994 | 17.9% | 7 | 39 (0.42) | |
| | | 1995 | 15.6% | 9 | 58 (0.59) | 47 (0.20) |
| **Minimum total annual takes 1991-95** | | | | | | 47 (0.20) |

**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. 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*): California/Oregon/Washington Pacific Coast 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; 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' and 'transient' (Bigg et al. 1990) based on aspects of morphology, ecology, genetics and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992). Although some resident pods have been sighted off the outer Washington coast as far south as Grays Harbor (Bigg et al. 1990), most sightings of killer whales in Washington have occurred in inland waterways.

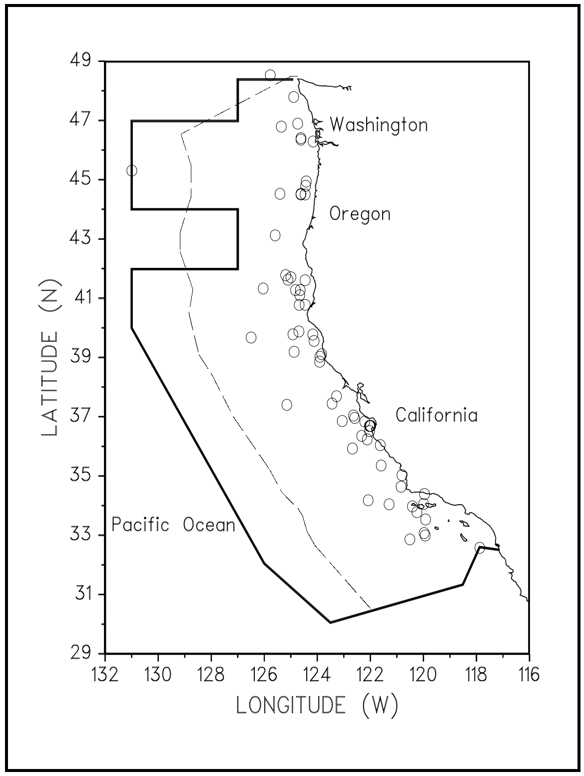


**Figure 1.** Killer whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys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

Off California, Oregon and the Pacific coast of Washington, killer whale sightings have been relatively infrequent and dispersed (Figure 1). Although movement between Alaska and California recently was documented for three identifiable killer whales photographed together in both regions (Black et al. 1993, Goley and Straley 1994), it is not known what proportion of animals found off California, Oregon and the outer Washington coast may exhibit similar long-range movements, or whether any resident pods exist in these areas. Until additional information on movements and population structure is available, killer whales within the U.S. Exclusive Economic Zone of offshore Washington waters (south of Cape Flattery), and in Oregon and California should be managed as a separate stock from the resident and transient populations which have been studied in the inland waterways of Washington and British Columbia and in Alaska. Thus, for the Marine Mammal Protection Act (MMPA) stock assessment reports, killer whales within the Pacific U.S. EEZ are divided into five stocks: 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 3) the Eastern North Pacific Transient stock - occurring from Alaska to the inland waters of Washington State, 4) the California/Oregon/Washington Pacific Coast stock (this report), and 5) the Hawaiian stock.

## POPULATION SIZE

Killer whales generally have been sighted too infrequently off the Pacific coast of California, Oregon and Washington to produce reliable abundance estimates. No abundance estimates have been made for offshore Oregon and Washington waters. For California, Forney (1994) reviews available data and concludes that the abundance estimate of 307 (C.V. = 1.2) obtained by Barlow (1995) based on a 1991 summer/fall ship survey extending 300 nmi off the California coast is likely to be the most accurate, although the variance in this estimate is high. Recently, Barlow and Gerrodette (1996) combined data from this 1991 survey with data from a similar survey conducted in 1993 and calculated a more precise abundance estimate of 747 (C.V. =0.71). This value represents the best population estimate for this stock, although it does not include any killer whales that may have been off Oregon or Washington at the time of the 1991 and 1993 surveys. 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), an abundance estimate for the entire defined stock range will be available.

### Minimum Population Estimate

The log-normal 20th percentile of the above abundance estimate is 436 killer whales.

### Current Population Trend

No information is available regarding trends in abundance of killer whales off California, Oregon and the outer coast of Washington.

## 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 given the precision of the estimate of annual fishery mortality (CV=1.00), the recovery factor ($F_r$) is 0.4. ½$R_{max}$ is the default value of 0.02. Multiplying these two values times the minimum population estimate of 436 yields a potential biological removal (PBR) of 3.5 animals per year.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fishery Information

A summary of recent fishery mortality and injury for this stock of killer whale 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 killer whales in 1991-95 is 1/3,125 = 0.0003 whales per fishing day, or one killer whale every 3,125 fishing days (Julian and Beeson, in press). The average annual mortality for the five most recent years of monitoring, 1991-95, is 1.2 (CV=1.00) killer whales.

**Table 1.** Summary of available information on the incidental mortality and injury of killer whales (California/ Oregon/Washington Pacific Coast 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.

| 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** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>0<br>0<br>0<br>1 | 0<br>0<br>0<br>0<br>6 (0.92) | 1.2 (1.00) |
| **Minimum total annual takes 1991-95** | | | | | | 1.2 (1.00) |

Additional potential sources of killer whale mortality are set gillnets and longlines. In California, an 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 California/Oregon/Washington longline fisheries, but no such interactions have been documented to date.

Similar 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 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.

**Other 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), but it is unknown whether this animal may have belonged to a stock ranging south along the Pacific coast of California/Oregon/Washington.

**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. The average annual human-caused mortality (1.2 killer whales per year) is estimated to be less than the PBR (3.5), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for killer 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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# KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). In Alaskan waters, killer whales occur along the entire Alaska coast from the Chukchi Sea, into the Bering Sea, along the Aleutian Islands, Gulf of Alaska, and into Southeast Alaska (Braham and Dahlheim 1982). Their occurrence has been well documented throughout British Columbia and inland waterways of Washington state (Bigg et al. 1990), as well as along the outer coasts of Washington, Oregon, and California (Green et al. 1992, Barlow 1995, 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 (Bigg et al. 1990). 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); 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).

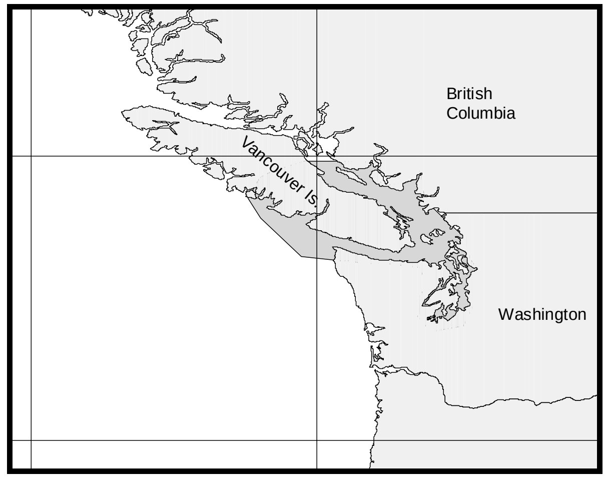


**Figure 1.** Approximate distribution of the Eastern North Pacific Southern Resident killer whale stock (shaded area).

Killer whales along British Columbia and Washington have been labeled as ‘resident’ and ‘transient’ (Bigg et al. 1990). Although less is known about killer whales in Alaska, both forms (‘resident’ and ‘transient’) have been shown to occur in Alaska waters (Matkin and Saulitis 1994). These two sympatric forms are believed to differ in several aspects of morphology, ecology, and behavior; that is, dorsal fin shape, saddle patch shape, pod size, home range size, diet, travel routes, dive duration, and social integrity of pods. For example, in Pacific Northwest waters, significant differences occur in call repertoires (Ford and Fisher 1982), saddle patch pigmentation (Baird and Stacey 1988), and diet (Baird et al. 1992). Studies on mtDNA restriction patterns provide evidence that the ‘resident’ and ‘transient’ pods are genetically distinct (Stevens et al. 1989, Hoelzel 1991, Hoelzel and Dover 1991, Hoelzel et al. in press). 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. in press). It should be noted, however, this genetic analysis also suggests that a small fraction of the ‘resident’ whales occurring in Southeast Alaska have the same genetic structure as that documented for the ‘resident’ whales in Washington’s inland waters.

Though the genetic analysis discussed above suggests that the ‘transient’ killer whales occurring from California through Alaska have the same genetic structure, for the purposes of the Marine Mammal Protection Act (MMPA) stock assessments the ‘transient’ stock has been divided (at Cape Flattery, WA) into two management units (stocks) to account for fisheries which are most likely to take killer whales incidentally. Therefore, based primarily on genetic differences and potential fishery interactions, 4 killer whales stocks are recognized along the west coast of North America from California to Alaska: 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 and southern British Columbia (see Fig. 1), 3) the Eastern North Pacific Transient stock - occurring from Alaska to Cape Flattery, and 4) the California/Oregon/ Washington Pacific Coast stock - occurring from Cape Flattery through California. The Stock Assessment Reports for the Alaska Region contain information concerning the Eastern North Pacific Northern Resident stock, and the Eastern North Pacific Transient stock.

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. One killer whale biopsied 300 miles west of the Columbia River entrance was reported to have the same genetic structure as the Eastern North Pacific Southern Resident stock (M. Dahlheim, pers. comm.). Relative to the killer whales of inland Washington, British Columbia, and Southeast Alaska, little is known about the killer whales found off the west coast of the continental U. S. (south of Cape Flattery), where sightings have been relatively infrequent and dispersed. Accordingly, until additional information on movements and population structure is available and taking into account fisheries likely to take killer whales incidentally, killer whales south of Cape Flattery along the U. S. west coast are being managed as a single stock - the California/Oregon/ Washington Pacific Coast stock. A separate report in this volume contains information concerning that stock.

## POPULATION SIZE

In the early 1970s, researchers began collecting identification photographs of killer whales in Washington inland and southern British Columbia waters to assess the impact of live-capturing for public display and aquaria (Ford et al. 1994). Photo-identification of individual whales through the years has resulted in a substantial understanding of this stock's structure, behaviors, and movements. As of 1993, the three pods comprising this stock totaled 96 killer whales (Ford et al. 1994). Counts have remained in the mid 90's since 1993 (D. Ellifrit, pers. comm.).

### 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. Given that researchers continue to identify new whales, although the rate of new discovery is very low, the estimate of abundance based on the number of uniquely identified individuals known to be alive is likely conservative. Additional estimates of the overall population size (i.e., $N_{BEST}$) and associated coefficient of variation (CV) are not currently available. Thus, the minimum population estimate ($N_{MIN}$) for the Eastern North Pacific Southern Resident stock of killer whales is 96.

### Current Population Trend

During the live-capture fishery that existed from 1967-73, 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 has increased approximately 35%, from 71 to 96 individuals (Ford et al. 1994). This represents an annual growth rate of 1.8% during those years.

## 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 1973-87 ( 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, these estimates are not a 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 1.0, the value for cetacean stocks of unknown status that are known to be increasing (Wade and Angliss 1997). Thus, for the Eastern North Pacific Southern Resident killer whale stock, PBR = 1.9 animals (96 x 0.02 x 1.0).

## ANNUAL 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 47-87% in this fishery during the 1990s, excluding 1994 in which no observer program occurred (Gearin et al. 1994, 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 resulted in no entanglements.

In 1994, NMFS and Washington Department of Fish and Wildlife (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 with killer whales mortalities were reported in either treaty salmon gillnet fishery.

**Table 1.** Summary of incidental mortality of killer whales (Eastern North Pacific Southern Resident stock) due to commercial fisheries from 1990 through 1995 and calculation of the mean annual mortality rate. n/a indicates that data are not available.

| Fishery name | Years | Data type | Range of observer coverage | Observed mortality (in given yrs.) | Estimated mortality (in given yrs.) | Mean annual mortality |
|---|---|---|---|---|---|---|
| Northern WA marine set gillnet | 90-95 | obs data | 47-87% | 0, 0, 0, 0, n/a, 0 | 0, 0, 0, 0, n/a, 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 |
| 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 |

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 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). 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 logbook reports maintained by vessel operators as required by the MMPA interim exemption program. During the 4-year period between 1990-93 logbook reports did not indicate any mortalities of killer whales within the range of this stock. Complete logbook data after 1993 are not available.

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 estimated annual level of human-caused mortality and serious injury of zero animals per year is not known to exceed the PBR (1.9). Therefore, the Eastern North Pacific Southern Resident stock of killer whales is not classified as a strategic stock. The total fishery mortality and serious injury for this stock (0) is not known to exceed 10% of the calculated PBR (0.19) and, therefore, can be 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 this stock relative to OSP.

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# SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): California/Oregon/Washington Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Short-finned pilot whales were once commonly seen off Southern California, with an apparently resident population around Santa Catalina Island, as well as seasonal migrants (Dohl et al. 1980). After a strong El Niño event in 1982-83, short-finned pilot whales virtually disappeared from this region, and despite increased survey effort along the entire U.S. west coast, few sightings were made from 1984-1992 (Jones and Szczepaniak 1992; Hill and Barlow 1992; 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 (Mangels and Gerrodette 1994; NMFS, unpublished data), and mortality in drift gillnets increased (Julian and Beeson, in press). 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 is 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.

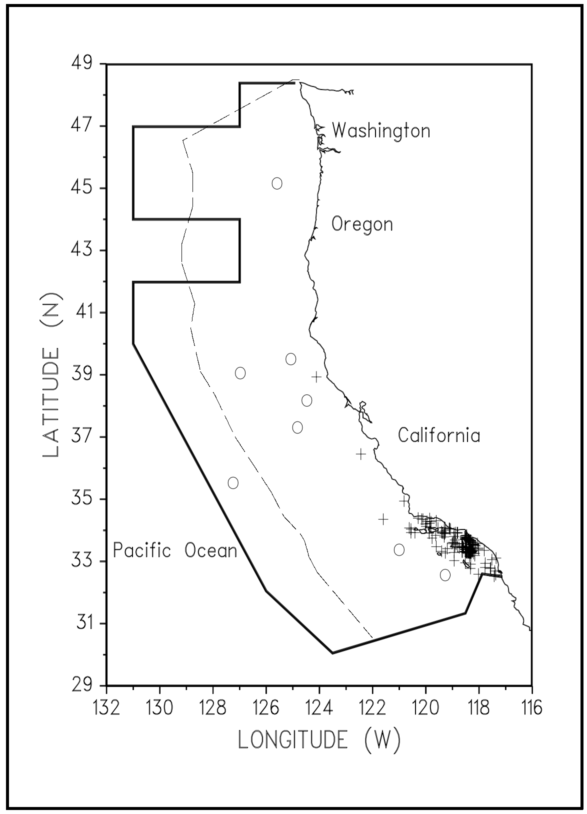


**Figure 1.** Short-finned pilot whale sightings made during aerial and shipboard surveys conducted off California in 1975-83 (+) and off California, Oregon and Washington in 1989-94 (○) (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

## POPULATION SIZE

Based on surveys conducted within 300 nmi of the California coast in 1991 and 1993, Barlow and Gerrodette (1996) have recently calculated an abundance estimate of 1,004 (C.V. = 0.37) short-finned pilot whales.

### Minimum Population Estimate

The log-normal 20th percentile of the above abundance estimate is 741 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 (NMFS, unpublished data; Julian and Beeson, in press). 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=0.88), the recovery factor ($F_r$) is 0.40. ½$R_{max}$ is the default value of 0.02. Multiplying these two values times the minimum population estimate of 741 yields a potential biological removal (PBR) of 5.9 animals per year.

## ANNUAL 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. In the California drift gillnet fishery, the observed average rate of kill for short-finned pilot whales in 1991-95 is 9/3,125 = 0.0029 whales per fishing day, or one whale every 347 fishing days (Julian and Beeson, in press). The average estimated annual mortality for short-finned pilot whales in this fishery for the five most recent years of monitoring, 1991-95, is 13 (CV=0.88) animals.

**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.

| 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** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>1<br>8<br>0<br>0 | 0<br>7 (0.92)<br>60 (0.54)<br>0<br>0 | 13 (0.88) |
| **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 1991-95** | | | | | | 13 (0.88) |

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.

Historically, short-finned pilot whales were also killed in squid purse seine operations off Southern California (Miller et al. 1983; Heyning et al. 1994), although the extent of such mortality is unknown, and it probably represented animals killed intentionally to protect catch or gear, rather than incidental mortality. Such intentional takes are now illegal under the 1994 Amendments to the MMPA. No recent mortality has been reported, presumably because short-finned pilot whales have not returned to the areas of squid purse seine fishing activity. However, this fishery is not currently monitored, and has expanded markedly since 1992 (California Department of Fish and Game, unpubl. data).

## 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 1991-95 (13 animals per year) exceeds the PBR (5.9) 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.

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# 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 from late spring to early fall (Figure 1). 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.

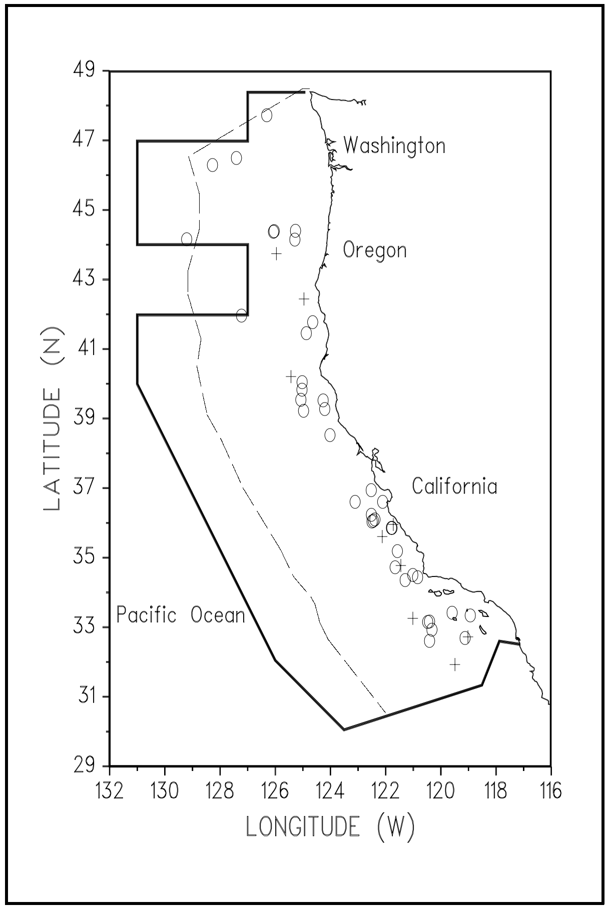


**Figure 1.** Baird's beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-1994. Key: ○ = May-October; + = November-April (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined.

## POPULATION SIZE

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 (C.V. = 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.

### Minimum Population Estimate

Based on the above abundance estimate and C.V., 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. 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. ½$R_{max}$ 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.

## 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.

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 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.

| 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** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>0<br>0<br>1<br>0 | 0<br>0<br>0<br>6 (0.90)<br>0 | 1.2 (1.00) |
| **Minimum total annual takes 1991-95** | | | | | | 1.2 (1.00) |

### 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.

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Revised 08/01/97

# 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 (i.e. genetic tests) to obtain species-specific abundance and mortality 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.

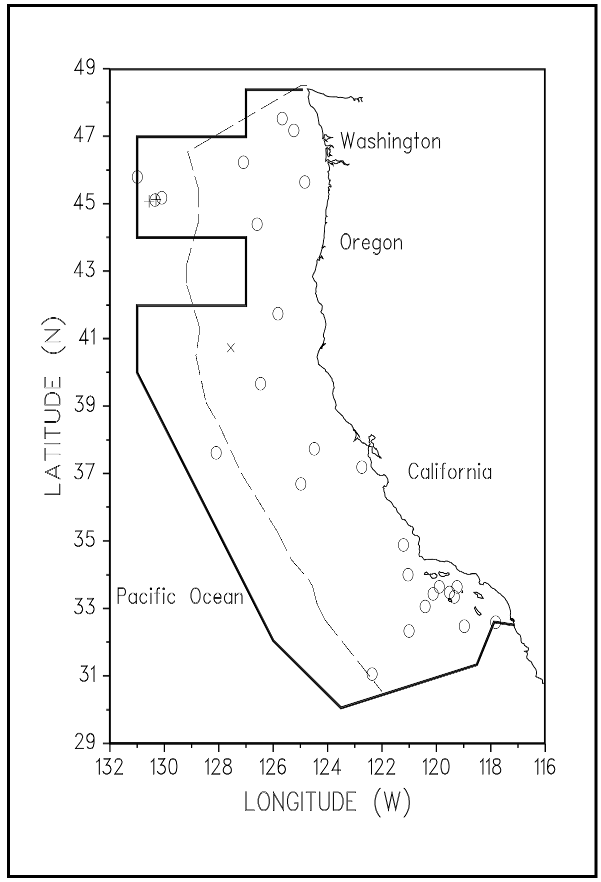


**Figure 1.** *Mesoplodon* beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-1994. Key: ○ = *Mesoplodon* sp.; + = *Mesoplodon carlhubbsi*; × = *Mesoplodon densirostris* (see Appendix 2 for data sources and information on timing and location of survey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

## POPULATION SIZE

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 observe 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) have resulted in improved estimates of abundance by 1) combining data from two surveys conducted in 1991 and 1993 within 300 nmi of the California coast, 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). Furthermore, the first species-specific abundance estimate is now available for Blainville’s beaked whale, which was identified once during the 1993 cruise. Combining the abundance estimates in Barlow and Gerrodette (1996) with the correction factor estimated by Barlow and Sexton (1996), the new estimates of abundance are 1,378 (C.V. = 0.58) mesoplodont beaked whales of unknown species plus 728 (C.V. = 2.03) Blainville's beaked whales. These estimates are probably still biased downward by an unknown amount, however, because the surveys did not cover Oregon and Washington waters. After analysis results become available for a comprehensive shipboard survey 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 combined abundance estimate of 2,106 (CV=0.80), 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 1,169 animals. This includes a species-specific minimum abundance estimate of 249 Blainville’s beaked whales. These estimates 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 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. ½$R_{max}$ is the default value of 0.02. Multiplying these two values times the minimum population estimate of 1,169 yields a potential biological removal (PBR) of 11 mesoplodont beaked whales per year, including at least 2.2 Blainville’s beaked whales per year.

## ANNUAL 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. 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 whales are likely to have been *Mesoplodon* spp. The observed average rates of kill for mesoplodont beaked whales in the California drift gillnet fishery in 1991-95 are 1/3,125 = 0.0003 Stejneger’s beaked whales per fishing day, or one every 3,125 fishing days; 5/3,125 = 0.0016 Hubbs’ beaked whales per fishing day, or one every 625 fishing days; and 1/3,125 = 0.0003 unidentified mesoplodont beaked whales per fishing day, or one every 3,125 fishing days (Julian and Beeson, in press). The average estimated annual mortality for all mesoplodont beaked whales in this fishery for the five most recent years of monitoring, 1991-95, 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).

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.

## 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 as "depleted" under the MMPA. The estimated annual human-caused mortality in 1991-95 for all mesoplodont beaked whales combined (9.2) is less than the PBR (11). However, it is very likely that the additional unidentified beaked whales were *Mesoplodon* spp., which would raise the mortality to 13 animals annually, exceeding the PBR. Given this overall estimate of mortality and the lack of species-specific abundance estimates for all but one *Mesoplodon* beaked whale, this group of species is 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. The status of *Mesoplodon* beaked whales can be re-evaluated when analyses have been completed for the shipboard survey conducted along the entire coast of California, Oregon and Washington in July - November 1996, providing an overall abundance estimate for the entire geographic range of these stocks. However, 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.

**Table 1.** Summary of available information on the incidental mortality and injury of *Mesoplodon* beaked whales (California/Oregon/Washington Stocks) in commercial fisheries that might take these species. All observed entanglements of *Mesoplodon* beaked whales resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses.

| 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** | Hubbs' beaked whale, *Mesoplodon carlhubbsi* | | | | | |
| | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>3<br>0<br>2<br>0 | 0<br>22 (0.53)<br>0<br>11 (0.64)<br>0 | 6.6 (0.67) |
| | Stejneger's beaked whale, *Mesoplodon stejnegeri* | | | | | |
| | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>0<br>0<br>1<br>0 | 0<br>0<br>0<br>6 (0.91)<br>0 | 1.2 (1.00) |
| | Unidentified *Mesoplodon* beaked whale | | | | | |
| | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>1<br>0<br>0<br>0 | 0<br>7 (0.93)<br>0<br>0<br>0 | 1.4 (1.00) |
| | Unidentified beaked whale (probably *Mesoplodon*) | | | | | |
| | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>2<br>0<br>1<br>0 | 0<br>15 (0.65)<br>0<br>6 (0.90)<br>0 | 4.2 (0.70) |
| **Minimum total annual takes of *Mesoplodon* beaked whales 1991-95** | | | | | | 9.2 (0.65) to 13 (0.66) |

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Sosa-Nishizaki, O., R. De la Rosa-Pacheco, R. Castro-Longoria, M. Grijalva Chon, and J. De la Rosa Velez. 1993. Estudio biologico pesquero del pez (*Xiphias gladius*) y otras especies de picudos (marlins y pez vela). Rep. Int. CICESE, CTECT9306.

Revised 08/01/97

# 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.

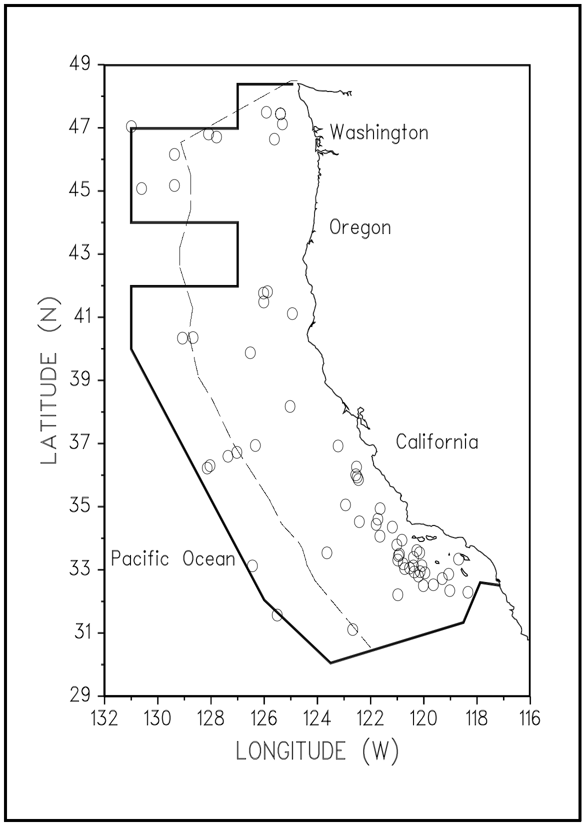


**Figure 1.** Cuvier's beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of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

## POPULATION SIZE

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 surveys conducted in 1991 and 1993 within 300 nmi of the California coast, 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). 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 (C.V. = 0.52) Cuvier's beaked whales. 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 C.V., 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 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 ½$R_{max}$ 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.

## 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.

**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 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).

| Fishery Name | Data Type | Year(s) | Percent Observer Coverage | Observed Mortality +Released Alive | Estimated Annual Mortality / Entanglements | Mean Annual Takes 1991-95 |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | observer data | 1991 | 9.8% | 0 | 0 | |
| | | 1992 | 13.6% | 6 | 44 (0.36) | |
| | | 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) | 28 (0.28) |
| **Minimum total annual takes 1991-95, including animal released alive** | | | | | | 28 (0.28) |

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.

## 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. 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

# 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 (Caldwell and Caldwell 1989; Ross 1984). 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, unpublished data; NMFS, 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.

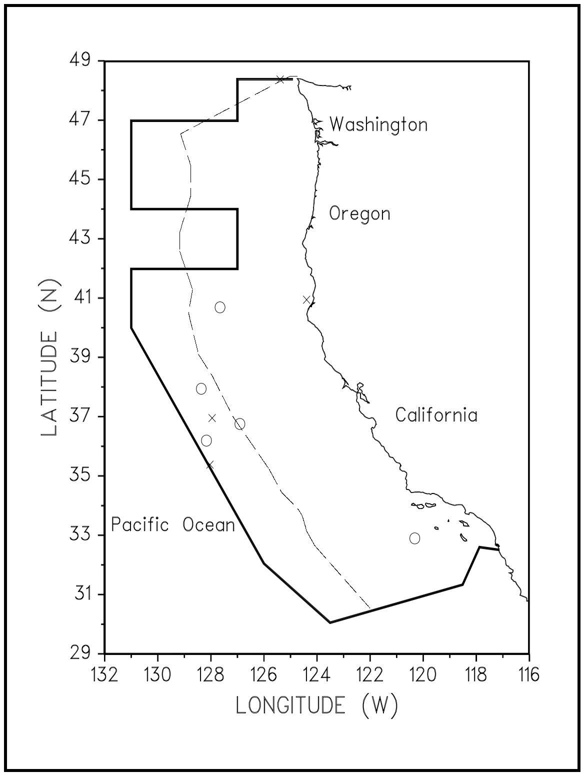


**Figure 1.** *Kogia* sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-1994. Key: ○ = *Kogia breviceps*; × = *Kogia* sp. (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line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

## POPULATION SIZE

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 surveys conducted in 1991 and 1993 within 300 nmi of the California coast, 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). 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 (C.V. = 0.54) pygmy sperm whales. Additionally, there are an estimated 891 (C.V. = 2.04) pygmy or dwarf sperm whales, based on sightings that could only be identified to the genus *Kogia*. 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 C.V., the minimum population estimate (defined as the log-normal 20th percentile of the abundance estimate) for pygmy sperm whales in California, Oregon, and Washington is 2,059 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. ½$R_{max}$ 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.

## 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 these fisheries 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

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 pygmy sperm whales and unidentified *Kogia* sp. (California/Oregon/ Washington Stock) in commercial fisheries that might take these species. All observed entanglements 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 *K. breviceps* /*Kogia* sp.** | **Estimated Annual Mortality of *K. breviceps/Kogia* sp.** | **Mean Annual Takes 1991-95** |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | observer data | 1991<br>1992<br>1993<br>1994<br>1995 | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0 / 0<br>0 / 1<br>1 / 0<br>0 / 0<br>0 / 0 | 0 / 0<br>0 / 7 (0.92)<br>7 (0.93) / 0<br>0 / 0<br>0 / 0 | 2.8 (0.61) |
| **Minimum total annual takes of pygmy sperm whales, 1991-95 (incl. unidentified *Kogia*)** | | | | | | 2.8 (0.61) |

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

## 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.

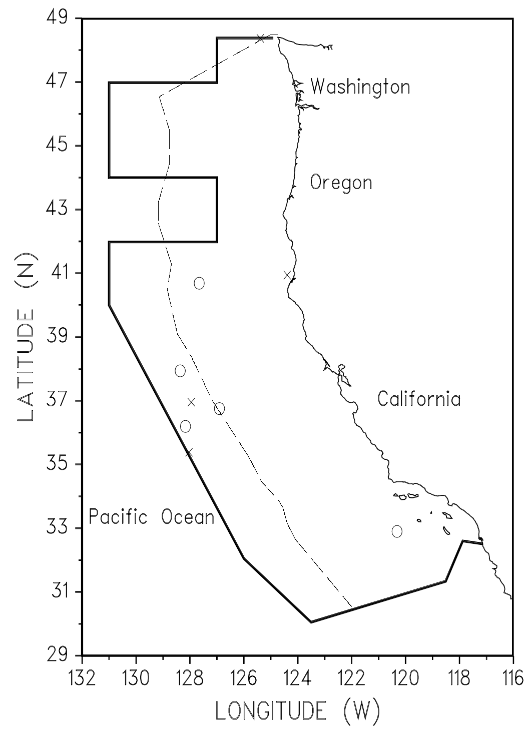


**Figure 1.** *Kogia* sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-1994. Key: ○ = *Kogia breviceps*; × = *Kogia* sp. (see Appendix 2 for data sources and information on timing and location of survey effort). Dashed line represents the U.S. EEZ, thick line 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 (C.V. = 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 ½$R_{max}$ 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 8/1/97

# 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 sperm whales that were marked off southern California in January, 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. Additional information on population structure in the eastern temperate Pacific was collected in Spring 1997 and will be evaluated over the next year.

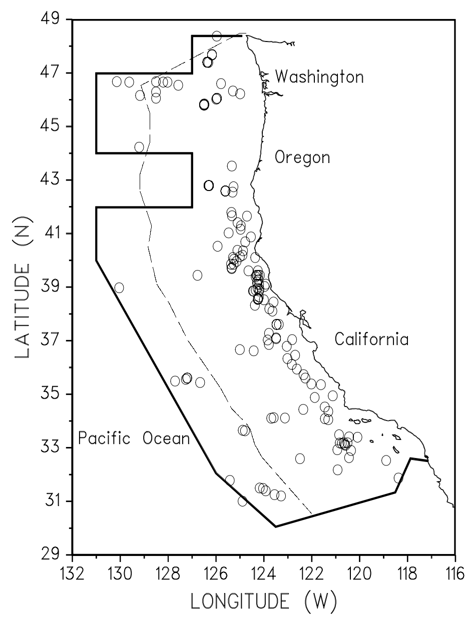


**Figure 1**. Sperm whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

For the Marine Mammal Protection Act (MMPA) stock assessment reports, sperm whales within the Pacific U.S. EEZ are divided into three discrete, non-contiguous areas: 1) California, Oregon and Washington waters (this report), 2) waters around Hawaii, and 3) Alaska waters.

## POPULATION SIZE

Barlow and Gerrodette (1996) estimate 1,231 (CV=0.39) sperm whales in California coastal waters during summer/fall based on ship line transect surveys in 1991 and 1993 (95% C.I.=586-2,583). Forney et al. (1995) estimate 892 (CV=0.99) sperm whales there 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 the true abundance would be 3 to 8 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. The only abundance estimates for the entire eastern North Pacific is for 1982 (Gosho et al. 1984) and is based on a CPUE method which is no longer accepted as valid by the International Whaling Commission. Using a different method (line transects), the abundance of sperm whales has been estimated recently as 22,700 (95% C.I.=14,800-34,600) in the eastern tropical Pacific (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. The most precise estimate of sperm whale abundance within the area of the drift gillnet fishery is therefore from the ship survey estimate of Barlow and Gerrodette (1996); however, theirs is probably an underestimate of true abundance because it does not include animals known to be in Oregon and Washington at that time. Surveys were conducted in summer/fall 1996 to estimate the abundance of cetaceans in California, Oregon, and Washington and in spring 1997 to estimate sperm whale abundance in the entire eastern temperate Pacific. Data from these new surveys will be analyzed and evaluated over the next year.

### 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 in California waters (Barlow and Gerrodette 1996) or approximately 896. 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. Additional information on the abundance of sperm whales in waters off Oregon and Washington will be available within the next year.

### Current Population Trend

Sperm whale abundance appears to have been fairly stable in California coastal waters between 1979/80 and 1991 (Barlow 1994). 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 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 (896) <u>times</u> one half the default maximum net growth rate for cetaceans (1/2 of 4%) <u>times</u> a recovery factor of 0.1 (the default value for an endangered species), resulting in a PBR of 1.8.

## ANNUAL HUMAN-CAUSED MORTALITY

### Historic Whaling

The reported take of North Pacific sperm whales by commercial whalers totaled 258,000 between 1947 and 1987 (C. Allison, IWC, pers. comm.). Based on the massive under-reporting of Soviet catches (Yablokov 1994), these estimates are probably much lower than the actual catches. Of these, 848 were taken by shore whaling stations in California between 1956 and 1970 (Rice 1974). 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

Sperm whales in this stock are likely to be caught only in offshore drift gillnets. A summary of known fishery mortality and injury for this stock of sperm whales is given in Table 1. Detailed information on this fishery is provided in Appendix 1. The average annual fishery mortality is estimated to be 4.5 sperm whales for the five most recent years of monitoring (1991-95). In addition, an estimated 4.5 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 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, Southwest Region, NMFS, pers. comm.).

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 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.

**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 and Beeson, in press). 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.

| Fishery Name | Year(s) | Data Type | Percent Observer Coverage | Observed Mortality (and injury in parentheses) | Estimated Mortality (CV in parentheses) | Mean Annual Takes 1991-95 (CV in parentheses) |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | 1991<br>1992<br>1993<br>1994<br>1995 | observer data | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>1 (2)<br>2 (1)<br>0<br>0 | Mortality<br>0,7 ,15,0,0<br>(0.94,0.66)<br>Injury<br>0,15,7,0,0 | Mortality<br>4.5 (0.54)<br><br>Injury<br>4.5 (n/a) |
| **Total annual takes** | | | | | | 9 (0.54) |

**Ship Strikes**

Ship strikes were implicated in the deaths of two unidentified whales (possibly sperm whales) in 1990 (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.

## STATUS OF STOCK

Overall, sperm whales were estimated to be at 88% of historical carrying capacity in the eastern North Pacific and 64% in the western North Pacific (Gosho et al. 1984), but as noted before, this 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 (4.5 per year) is greater than the calculated PBR for this stock (1.8) which would also result in the classification of this stock as “strategic”, and total fishery 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 off Oregon and Washington and does not include animals 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. . 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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# HUMPBACK WHALE (*Megaptera novaeangliae*): California/Oregon/Washington - Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Although the International Whaling Commission (IWC) only considered one stock (Donovan 1991), there is now good evidence for multiple populations of humpback whales in the North Pacific (Johnson and Wolman 1984; Baker et al. 1990). Four relatively separate migratory populations have been identified in the North Pacific (Barlow 1994a) based on sightings of distinctively-marked individuals: the coastal California/Oregon/Washington - Mexico stock, the Mexico offshore island stock (feeding destination unknown), the central North Pacific stock (Hawaii/Alaska), and the western North Pacific stock (Japan/feeding destination probably the Aleutian Islands). This assessment will cover the stock of humpback whales that ranges from Costa Rica (Steiger et al. 1991) to southern British Columbia (Calambokidis et al. 1993) but which is most common in coastal waters off California (in summer/fall) and Mexico (in winter/spring). Other Marine Mammal Protection Act (MMPA) stock assessment reports include the central North Pacific (Hawaii/Alaska) stock and the western North Pacific (Japan/?) stock. 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.

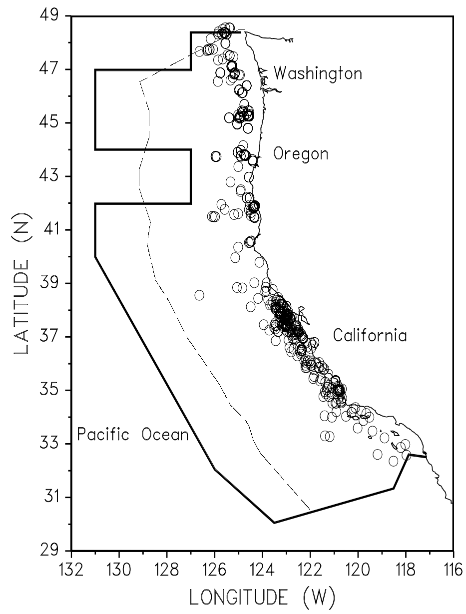


**Figure 1**. Humpback whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

## POPULATION SIZE

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 3,000 humpback whales (Barlow 1994a). 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 and Steiger (1994) estimated the number of humpback whales in California-Washington to be 597 (CV=0.07) based on mark-recapture estimates comparing their 1992 and 1993 photo-identification catalogs. 2) Barlow and Gerrodette (1996) estimate 577 (CV=0.31) humpbacks in California waters based on ship line-transect surveys in summer/autumn of 1991 and 1993. 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. 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, but the survey estimates are likely to be negatively biased. The aerial surveys are likely to be biased because submerged animals are missed, and both the ship and aerial line-transect estimates do not include members of this stock that were in Washington, Oregon, or Mexico at the time of the survey (this is especially true of the winter/spring survey, during which it was surprising to see any humpback whales north of Mexico). 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 1992-93 catalog contained 480 known individuals), this bias is likely to be minimal. Also, 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 597 (CV=0.07) 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 1992-93 abundance estimated from mark-recapture methods (Calambokidis and Steiger 1994) or approximately 563.

### Current Population Trend

There is some indication that humpback whales have increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1994b) and between 1991 and 1993 (Barlow and Gerrodette 1996), but these trends are not statistically significant. Mark-recapture population estimates have increased steadily from 1988/90 to 1992/93 at about 5% per year (Calambokidis and Steiger 1994). 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.

## 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 appears much lower than has been measured for humpback whales in other areas (Calambokidis and Steiger 1994).

## POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (563) 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 1.1. Because this stock spends approximately half its time in Mexican waters, the PBR allocation for U.S. waters is 0.5 whales per year.

## ANNUAL HUMAN-CAUSED MORTALITY

### Historic Whaling

The reported take of North Pacific humpback whales by commercial whalers totalled approximately 7,700 between 1947 and 1987 (C. Allison, IWC, 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 likely to be caught only in offshore drift gillnets. A summary of known fishery mortality and injury for this stock of humpback whales is given in Table 1. Detailed information on this fishery is provided in Appendix 1. The average fishery mortality and injury is estimated to be 1.2 humpback whales per year for the five most recent years of monitoring (1991-95) based on the observation of one entangled whale (released alive). 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 humpback whale was observed off Ventura, CA in 1993 with a 20 ft section of netting wrapped around and trailing behind.

Similar drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably take animals from the same population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which 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.

**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 and Beeson, in press). 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.

| Fishery Name | Year(s) | Data Type | Percent Observer Coverage | Observed Mortality (and Injury) | Estimated Mortality (CV in parentheses) | Mean Annual Takes 1991-95 (CV in parentheses) |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | 1991<br>1992<br>1993<br>1994<br>1995 | observer data | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>0<br>0<br>0 (1)<br>0 | Mortality<br>0,0,0,0,0<br><br>Injury<br>0,0,0,6,0<br>(0.91) | Mortality<br>0<br><br>Injury<br>1.2 (0.91) |
| **CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery** | 1991-95 | observer data | 10-15% | 0,0,0,0,0 | 0,0,0,0,0 | 0 |
| **Total annual takes** | | | | | | 1.2 (0.91) |

### Ship Strikes

Ship strikes were implicated in the deaths of at least two humpback whales in 1993 and one humpback whale in 1995 (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 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 from 1991-95 is at least 0.6 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 (1.2/yr) plus ship strikes (0.6/yr) in California is thus greater than the PBR allocation of 0.5 for U.S. waters. If none of the injuries from gillnet entanglement resulted in death, the mortality due to ship strikes alone would still exceed the PBR. 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 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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# BLUE WHALE (*Balaenoptera musculus*): California/Mexico 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). One group of animals migrates from Mexico to feed in California waters from June to November. 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 Rican Dome in the eastern tropical Pacific from June to November, Reilly and Thayer (1990) speculate that these are likely to be part of a southern hemisphere population or an isolated resident population. 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.

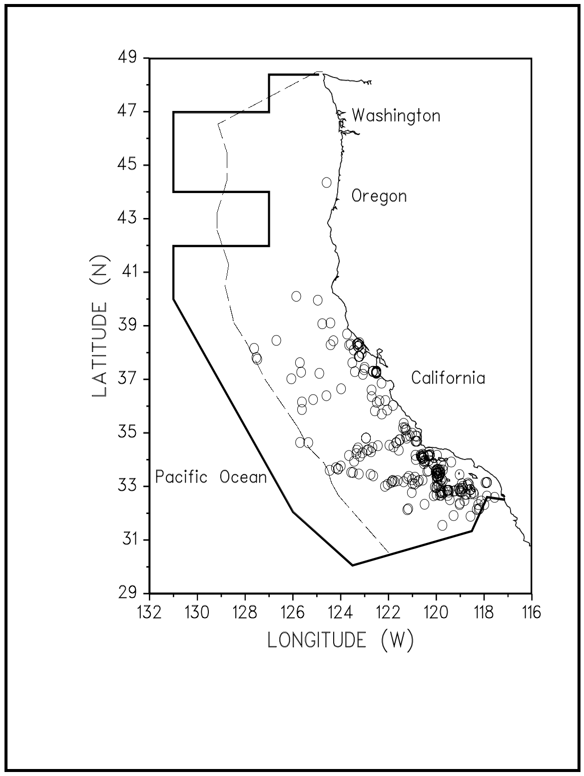


**Figure 1**. Blue whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys 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 and Gerrodette (1996) estimate 1,723 (CV=0.23) blue whales in California waters based on ship line-transect surveys. 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 1,785 (CV=0.24). No blue whales were seen in recent aerial 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 1,463.

**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 1993 (not significant, Barlow 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 is too large to be accounted for by population growth alone. 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 (1,463) 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 2.9. Because this stock spends approximately half its time in Mexican waters, the PBR allocation for U.S. waters is 1.5 whales per year.

## ANNUAL HUMAN-CAUSED MORTALITY

**Historic Whaling**

The reported take of North Pacific blue whales by commercial whalers totalled 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 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**

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. 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, Mexico and probably 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 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.

**Table 1.** Summary of available information on the incidental mortality and injury of blue whales (CA/Mexico stock) for commercial fisheries that might take this species (Julian and Beeson, in press).

| 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 | observer data | 10-18% | 0,0,0,0,0 | 0,0,0,0,0 | 0 |
| **Total annual takes** | | | | | | 0 |

**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 0.2 per year 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 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 whales, particularly for baleen whales that may communicate using low-frequency sound.

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Revised 8/1/97

# 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 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 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). Fin whales appear very scarce in the eastern tropical Pacific in summer (Wade and Gerrodette 1993) and winter (Lee 1993).

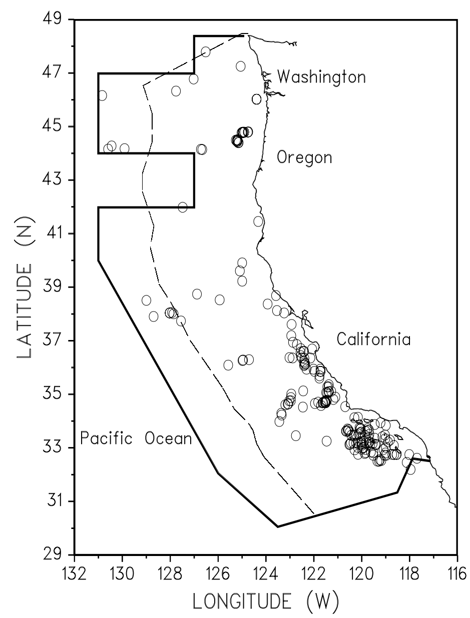


**Figure 1**. Fin whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys 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, 933 (CV=0.27) fin whales were estimated to be in California waters based on ship surveys in summer/autumn of 1991 and 1993 (log-normal 95% C.I.=555-1,569) (Barlow 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 and Gerrodette 1996) or approximately 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 1993 (Barlow 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 (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 1.5.

## ANNUAL 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). Fin whales in the North Pacific were given protected status by the IWC in 1976.

### Fisheries Information

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. 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 and Beeson, in press).

| 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 | observer data | 10-18% | 0,0,0,0,0 | 0,0,0,0,0 | 0 |
| **Average annual takes** | | | | | | 0 |

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 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.

### Ship Strikes

Ship strikes were implicated in the deaths of one fin whale in 1991 and 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.

**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 incidental mortality due to fisheries and ship strikes appears to be less than 1 animal per year and is therefore less than the calculated PBR (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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Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

Revised 8/1/97

# 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 (Wade and Gerrodette 1993; Lee 1993) have shown them to be common and distributed throughout the eastern tropical Pacific with a concentration around the equator east of 110ºW (corresponding approximately to the IWC's "Peruvian stock") and a reduction west of 140ºW. 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 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 150ºW and including the Gulf of California and waters off California; this report), and 2) Hawaiian waters.

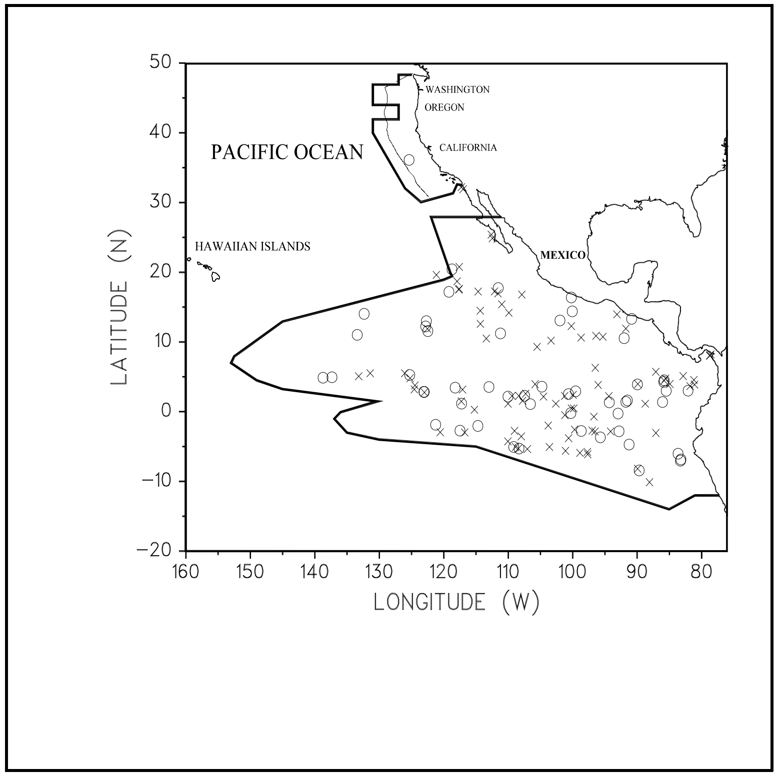


**Figure 1**. Sighting locations of Bryde's whales (O) and unidentified Bryde’s or sei whale (X) based on aerial and shipboard surveys off California, Oregon, and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of surveys) and in the eastern tropical Pacific, 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 1 confirmed sighting of Bryde's 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 (Hill and Barlow 1992; Carretta and Forney 1993; Mangels and Gerrodette 1994). Green et al. (1992) did not report any sightings of Bryde's whales in aerial surveys of Oregon and Washington. The estimated abundance of Bryde's whales in California coastal waters is 24 (CV=2.0) (Barlow 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 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.

## ANNUAL 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 and Beeson, in press). 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 1991-95 (CV in parentheses) |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | 1991-95 | observer data | 10-18% | 0,0,0,0,0 | 0,0,0,0,0 | 0 |
| **Mexico thresher shark/swordfish drift gillnet fishery** | 1991-95 | observer data | n/a | n/a | n/a | n/a |
| | | | | | **Total annual takes** | 0 |

### Fishery Information

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. 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, Mexico and probably 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 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.

**Ship Strikes**

Ship strikes may occasionally kill Bryde's whales as they are known to kill their larger relatives: blue and fin whales.

**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 mortality rate 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

# 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 distributed continuously across the North Pacific between 45-55°N (Masaki 1977). Two sei whales that were tagged off California were later killed off Washington and British Columbia (Rice 1974) and the movement of tagged animals has been noted in many other regions of the North Pacific. Sei whales are now rare in California waters (Dohl et al. 1983; Barlow 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 180°) will be considered as a separate stock.

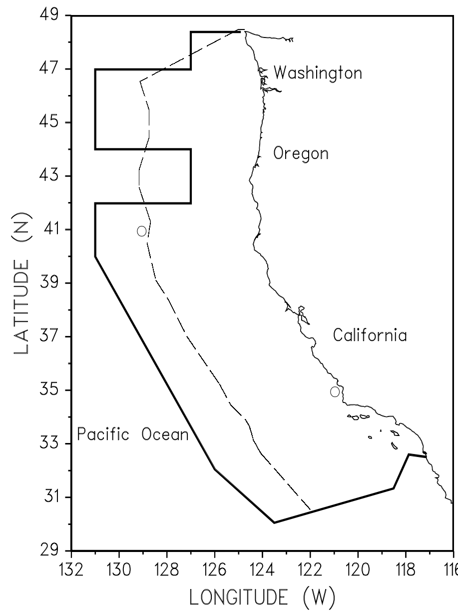


**Figure 1**. Sei whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys 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 (Hill and Barlow 1992; Carretta and Forney 1993; Mangels and Gerrodette 1994). 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.

## ANNUAL 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

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. 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 and Beeson, in press). 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 1991-95 (CV in parentheses) |
|---|---|---|---|---|---|---|
| **CA/OR thresher shark/swordfish drift gillnet fishery** | 1991-95 | observer data | 10-18% | 0,0,0,0,0 | 0,0,0,0,0 | 0 |
| **Total annual takes** | | | | | | 0 |

### 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.

## 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). 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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# 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 180ºN, 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) 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.

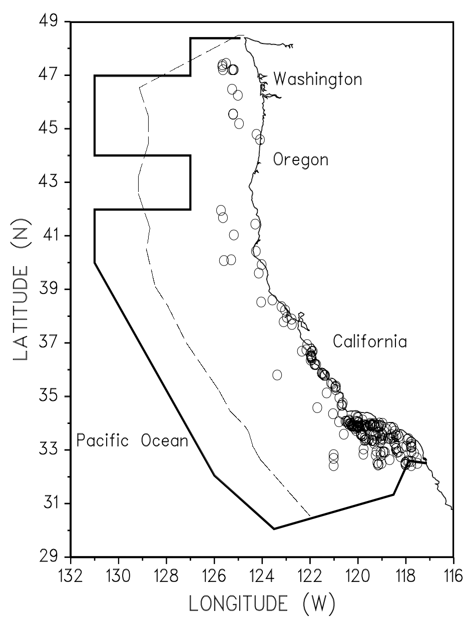


**Figure 1**. Minke whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1975-94 (see Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

## POPULATION SIZE

No estimates have been made for the number of minke whales in the entire North Pacific. In California coastal waters, the number of minke whales is estimated as 201 (CV=0.65, log-normal 95% C.I.=63-646) (Barlow and Gerrodette 1996). Forney et al. (1995) estimate at total of 73 (CV=0.62) in the same area 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. Ship surveys in summer/fall 1996 will produce a new estimate of minke whale abundance that will include California, Oregon, and Washington.

### 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 waters (Barlow and Gerrodette 1996) or approximately 122. 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. Minimum estimates of abundance are still needed for Oregon and Washington.

### 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 (122) times one half the default maximum net growth rate for cetaceans (1/2 of 4%) times a recovery factor of 0.4 (for a stock of unknown status and a mortality CV=0.9), resulting in a PBR of 1.0.

## ANNUAL 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 totalled 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 and Beeson, in press).

| 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<br>1992<br>1993<br>1994<br>1995 | observer data | 9.8%<br>13.6%<br>13.4%<br>17.9%<br>15.6% | 0<br>0<br>0<br>1<br>0 | 0<br>0<br>0<br>6 (0.91)<br>0 | 1.2 (0.91) |
| **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** | 1991-95 | observer data | 10-18% | 0,0,0,0,0 | 0,0,0,0,0 | 0 |
| **Total annual takes** | | | | | | 1.2 (0.91) |

### Fishery Information

Minke whales may occasionally be caught in coastal set gillnets off California, in salmon drift gillnet in Puget Sound, Washington, and in offshore drift gillnets off California and Oregon. A summary of known fishery mortality and injury for this stock of minke whales is given in Table 1. Detailed information on this fishery is provided in Appendix 1. The average fishery mortality is estimated to be1.2 minke whales per year for the five most recent years of monitoring (1991-95). Total fishery mortality for minke whales was not estimated for the 1980-86 California Department of Fish and Game observer program, 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, 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 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. The number of set gillnets used in Mexico is unknown.

### 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.). 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 3 years, the annual mortality due to fisheries and ship strikes (1.2) is slightly greater than the calculated PBR for this stock (1.0), so they are considered a "strategic" stock under the MMPA. Fishery mortality alone is greater 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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# 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). 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.

## 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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). 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).

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.

**Other Mortality**

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 is unknown. The stock's status relative to OSP under the MMPA is also unknown. The species is not listed as threatened or endangered under the Endangered Species Act (1973). Although information on rough-toothed 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.

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# 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). They appear to be rare in Hawaiian waters. 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.

## 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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 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 is unknown. The stock's status relative to OSP under the MMPA is also unknown. The species is not listed as threatened or endangered under the Endangered Species Act (1973). Although information on Risso's 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.

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# 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). 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.

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 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 He 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). They 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). 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. 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.

**Other Mortality**

At least 36 bottlenose dolphins were live-captured in Hawaiian waters between 1963 and 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 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 is unknown. 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). Although information on bottlenose dolphins in Hawaiian waters is limited, this stock would be considered non-strategic under the 1994 amendments to the MMPA given the insignificance of reported fisheries related mortality.

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

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Pantropical spotted dolphins are primarily found in tropical and subtropical waters worldwide (Perrin and Hohn 1994). Much of what is known about the species in the North Pacific has been learned from specimens obtained in the large directed fishery in Japan and in the eastern tropical Pacific (ETP) tuna purse-seine fishery (Perrin and Hohn 1994). These dolphins are common and abundant throughout the Hawaiian archipelago, particularly in channels between islands, over offshore banks (e.g. Penguin Banks), and off the lee shores of the islands (see Shallenberger 1981). 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.* 1994). 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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.

**Other Mortality**

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 is unknown. The stock's status relative to OSP under the MMPA is also unknown. The species is not listed as threatened or endangered under the Endangered Species Act (1973). 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.

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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). 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 referrable to the subspecies *S. longirostris longirostris*, which occurs pantropically (Perrin 1990). For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands. Spinner dolphins involved in eastern tropical Pacific tuna purse-seine fisheries are managed separately under the MMPA.

## POPULATION SIZE

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, 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.

### 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.

### 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.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

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 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, Donovan and Barlow 1994).

### Fishery Information

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 there are records of spinner dolphins taken in inshore monofilament gillnets and net fragments in Hawaiian waters (Nitta and Henderson 1993).

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.

### Other Mortality

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 is unknown. The stock's status relative to OSP under the MMPA is alsounknown. They are not listed as threatened or endangered under the U.S. Endangered Species Act (1973). The Hawaiian stock 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.

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# STRIPED DOLPHIN (*Stenella coeruleoalba*): Hawaiian Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Striped dolphins are found in tropical to warm-temperate waters throughout the world (Perrin *et al.* 1994). There is an incongruity between the frequency of strandings and the infrequency of sightings of this species in Hawaii. Nitta (1991) found more stranding records of striped dolphins (13) than of any other species between 1936 and 1988, yet Shallenberger (1981) was aware of only two at-sea sightings, one near Niihau and one west of Oahu. 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.

## 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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**

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# MELON-HEADED WHALE (*Peponocephala electra*): Hawaiian Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Melon-headed whales are found in tropical and warm-temperate waters throughout the world. The distribution of reported sightings suggests that the oceanic habitat of this species is primarily equatorial waters (Perryman *et al.* 1994). Small numbers have been taken in the eastern tropical Pacific, and they are occasionally killed in direct fisheries in Japan and elsewhere in the western Pacific. Large herds are seen regularly in Hawaiian waters, especially off the Waianae coast of Oahu, the north Kohala coast of Hawaii, and the leeward coast of Lanai (Shallenberger 1981). 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.

## 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. 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).

### 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.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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**

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 is unknown. 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). Although information on melon-headed 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.

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# 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. 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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.

**Other Mortality**

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 is unknown. The stock's status relative to OSP under the MMPA is also unknown. This species is not listed as threatened or endangered under the U.S. Endangered Species Act (1973). Although information on pygmy 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.

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# 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). 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.

## 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. 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 nm offshore, produced a minimum count of 470 false killer whales (Leatherwood and Reeves 1989).

### Minimum Population Estimate

No data from the past five years are available to make 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.).

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.

**Other Mortality**

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 is unknown. 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). 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.

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# KILLER WHALE (*Orcinus orca*): Hawaiian Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales are found worldwide in tropical to polar waters (Heyning and Dahlheim 1988). They are rare in Hawaiian waters. 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" stocks have been described for coastal waters of Alaska, British Columbia, and Washington (Bigg 1982; Leatherwood *et al.* 1990), 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) aHawaiian 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.

## POPULATION SIZE

Population sizes for killer whales in the coastal waters of British Columbia and Washington are known from photoidentification 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.

### 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

No estimate of annual human-caused mortality and serious injury is available. 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 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, Donovan and Barlow 1994).

### Fishery Information

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 killer whales have been documented.

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 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 is unknown. The stocks status relative to OSP under the MMPA is unknown. This species is not listed as threatened or endangered under the Endangered Species Act (1973). Although information on killer whales in Hawaiian waters is limited, this stock would be considered non-strategic under the 1994 amendments to the MMPA given the insignificance of reported fisheries related mortality.

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# 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). 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 photoidentification 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.

## 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.

### Minimum Population Estimate

No minimum population estimate is available.

### 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

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, 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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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.

### Other Mortality

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 is unknown. The stock's status relative to OSP under the MMPA is unknown. This species is not listed as threatened or endangered under the U.S. Endangered Species Act (1973). Although information on short-finned pilot 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.

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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." 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.

## POPULATION SIZE

No data are available to estimate population size.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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 is unknown. The status of this stock relative to OSP under the MMPA is also unknown. This species is not listed as threatened or endangered under the Endangered Species Act (1973). Although information on Blainville's beaked 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.

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# 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). 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.

## 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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 is unknown. The stock's status relative to OSP under the MMPA is also unknown. The species is not listed as threatened or endangered under the Endangered Species Act (1973). Although information on Cuvier's beaked 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.

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# 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. 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.

## POPULATION SIZE

No data are available to estimate population size for this species in the central Pacific.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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 is unknown. 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). Although information on pygmy sperm 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.

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# 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). 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.

## 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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 is unknown. The stock's status relative to OSP under the MMPA is unknown. This species is not listed as threatened or endangered under the Endangered Species Act (1973). Although information on dwarf sperm whales in Hawaiian waters is limited, this stock would be considered non-strategic under the 1994 amendments to the MMPA given the insignificance of reported fisheries related mortality.

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# 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). 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), 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).

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. 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.

### Minimum Population Estimate

No data are available to make a minimum population estimate.

### 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.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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). Factory ships operated as far south as 20°N (Ohsumi 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 status of sperm whales in Hawaiian waters is unknown. 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.

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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. No sightings or strandings of blue whales have been reported in Hawaii. The only 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). 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). 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. No data are available to estimate population size for any other North Pacific blue whale population.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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, but no takes of blue whales have been documented (Nitta and Henderson 1993).

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 9500 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 is unknown. 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.

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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. There have been only two confirmed sightings off Oahu and a single stranding on Maui (Shallenberger 1981). Balcomb (1987) observed 8-12 fin whales in a multispecies feeding assemblage on 20 May 1966 approx. 250 mi. south of Honolulu. 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. The stock structure of fin whales in the North Pacific is uncertain (Mizroch *et al.* 1984). 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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). 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 is unknown. This 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.

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Revised 6/30/95

# 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.

### 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

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 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, Donovan and Barlow 1994).

### Fishery Information

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.

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 is unknown. 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. Although information on Bryde's 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.

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# Appendix 1.  Description of U.S. Commercial Fisheries

This appendix describes commercial fisheries that are currently active in California, Oregon, Washington, and Hawaii and that interact or may interact with marine mammals. The first three sections describe sources of marine mammal mortality data for these fisheries.  The fourth section describes the commercial fisheries for these states.  A list of all known fisheries for these states was published in the Federal Register, vol. 60, no. 249 dated 28 December 1995. 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 1-4 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 9-10 show trends of effort 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 in the NMFS Observer Program.  Data from this observer program is 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 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 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.  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.

**Table 1. Species reported to taken in the 1996 swordfish drift-net fishery. Reports to the Marine Mammal Authorization Program (MMAP) are compared with data reported from the NMFS Observer Program.**

<table>
<tr><th rowspan="2">Category I, CA/OR thresher shark/swordfish drift gillnet fishery</th><th colspan="2">Reported to the MMAP by fishers</th><th colspan="2">Reported by the NMFS Observer Program</th></tr>
<tr><th>Injured</th><th>Killed</th><th>Injured</th><th>Killed</th></tr>
<tr><td>Minke whale</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Sperm whale</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>Pacific white-sided dolphin</td><td>2</td><td>2</td><td>0</td><td>3</td></tr>
<tr><td>Common dolphin</td><td>19</td><td>6</td><td>0</td><td>28</td></tr>
<tr><td>Northern right-whale dolphin</td><td>0</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Dall’s porpoise</td><td>0</td><td>1</td><td>0</td><td>2</td></tr>
<tr><td>Unidentified Small cetacean</td><td>0</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td>California sea lion</td><td>0</td><td>6</td><td>0</td><td>4</td></tr>
<tr><td>Northern elephant seal</td><td>0</td><td>5</td><td>0</td><td>5</td></tr>
<tr><td>Total Occurrences Reported</td><td>22</td><td>26</td><td>1</td><td>48</td></tr>
<tr><th rowspan="2">Category I, CA large mesh (>3.5in) set gillnet fisheries (angel shark/halibut and other species)</th><th colspan="2">Reported to MMAP by fishers</th><th colspan="2">Reported by the NMFS Observer Program</th></tr>
<tr><th>Injured</th><th>Killed</th><th>Injured</th><th>Killed</th></tr>
<tr><td>Common dolphin</td><td>0</td><td>1</td><td colspan="2" rowspan="3">This fishery is not currently observed by NMFS or the state of California.</td></tr>
<tr><td>California sea lion</td><td>0</td><td>10</td></tr>
<tr><td>Harbor seal</td><td>0</td><td>2</td></tr>
</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. Human-related causes of mortality for sea lions include: entrainment in power station intakes, shooting, net fishery entanglement, and hook/line fishery interaction. A few incidents of gray whale entanglement were attributed to set net fishery entanglement and to trap fishery entanglement.

**Table 2. Strandings reported to the NMFS Marine Mammal Stranding Network during 1996.**

| Species | California MMSN | | Oregon and Washington MMSN | |
|---|---|---|---|---|
| | Number of Occurrences | % Human-Related (#) | Number of Occurrences | % Human-Related (#) |
| Harbor Porpoise | 18 | 16.7% (3) | 0 | 0% (0) |
| Dall's Porpoise | 2 | 0% (0) | 8 | 0% (0) |
| Pacific White-sided Dolphin | 1 | 0% (0) | 0 | 0% (0) |
| Risso's Dolphin | 1 | 0% (0) | 0 | 0% (0) |
| Bottlenose Dolphin | 3 | 0% (0) | 0 | 0% (0) |
| Common Dolphin | 30 | 0% (0) | 0 | 0% (0) |
| Killer Whale | 1 | 0% (0) | 0 | 0% (0) |
| Short-finned Pilot Whale | 0 | 0% (0) | 1 | 0% (0) |
| Stejneger's Beaked Whale | 0 | 0% (0) | 1 | 0% (0) |
| Cuvier's Beaked Whale | 1 | 0% (0) | 0 | 0% (0) |
| Unidentified Beaked Whale | 1 | 0% (0) | 0 | 0% (0) |
| Pygmy Sperm Whale | 2 | 0% (0) | 1 | 0% (0) |
| Gray Whale | 13 | 38.5% (5) | 4 | 0% (0) |
| Minke Whale | 1 | 0% (0) | 0 | 0% (0) |
| Blue Whale | 1 | 0% (0) | 0 | 0% (0) |
| Fin Whale | 1 | 100% (1) | 0 | 0% (0) |
| Humpback Whale | 1 | 0% (0) | 0 | 0% (0) |
| Unidentified Cetacean | 2 | 0% (0) | 0 | 0% (0) |
| Unidentified Porpoise | 0 | 0% (0) | 2 | 0% (0) |
| Unidentified Dolphin | 8 | 0% (0) | 0 | 0% (0) |
| Unidentified Whale | 1 | 0% (0) | 1 | 0% (0) |
| Unidentified Balaenopterid | 1 | 0% (0) | 0 | 0% (0) |
| Northern Fur Seal | 12 | 0% (0) | 0 | 0% (0) |
| Guadalupe Fur Seal | 2 | 0% (0) | 0 | 0% (0) |
| Steller (Northern) Sea Lion | 10 | 0% (0) | 2 | 0% (0) |
| California Sea Lion | 724 | 14.6% (106) | 30 | 23.3% (7) |
| Unidentified Sea Lion | 0 | 0% (0) | 23 | 4.76% (1) |
| Harbor Seal | 302 | 4.30% (13) | 109 | 19.3% (21) |
| Northern Elephant Seal | 240 | 2.08% (5) | 2 | 50% (1) |
| Unidentified Seal | 0 | 0% (0) | 21 | 0% (0) |
| Unidentified Pinniped | 159 | 0% (0) | 1 | 0% (0) |
| Totals for Cetaceans | 89 | 10.1% (9) | 18 | 0% (0) |
| Totals for Pinnipeds | 1449 | 8.63% (125) | 188 | 16.0% (30) |

**Appendix 1. Fishery Descriptions**

**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. There were 10 developmental fishery permits issued by the state of Oregon in 1996 and an additional 6 permits for 5 single deliveries each.[1]

Number of active permit holders: The number of vessels actively fishing during 1995 was 130.[2] The number of permit holders observed by NMFS observers during 1995 was 51.

Total effort: Estimated total effort for the drift-net fishery during calendar year 1995 is 3,673 effort-days where an effort-day is defined to be one day of effort by one vessel. (In this fishery, 1 effort-day is equivalent to 1 set.) The number of observed effort-days during 1995 was 572 (in 97 trips).

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 1-2 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.

Seasons: This fishery is subject to season-area restrictions. From 1 February to 15 May effort must be further than 200 nautical miles (nmi) from shore; from 16 May to 14 August, effort must be further than 75 nmi from shore, and from 15 August to 31 January there is no such restriction.

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. 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. 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. 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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[1] Pers. Comm. Jim Golden, Oregon Dept. of Fish and Wildlife.

[2] Beeson, M. J., 1996. Effort estimates of California gill net fisheries: halibut-angel shark set net, shark-swordfish drift net, white sea bass-yellowtail drift net, for January to December 1995. Report submitted to NOAA Fisheries/National Marine Fisheries Service, Southwest Region in partial fulfillment of Cooperative Agreement No. NA57FX0358. Available from Southwest Fisheries Science Center, La Jolla, CA.

**Appendix 1. Fishery Descriptions**

Number of permit holders: The number of legal permit holders in this fishery is approximately 80. Overall, the current number of legal permit holders for gill and trammel nets, excluding swordfish drift gillnets and herring gillnets, is 258 for the 1996/7 fishing season.

Number of active permit holders: Approximately 60; the number of permit holders observed by NMFS observers during 1994 was 22. During 1995, the number of boats fishing was 58.[2]

Total effort: 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. Approximate location of observed sets during 7/90-7/94, and 1/94-7/94 are shown in Figure 5-6, respectively. Approximate location of marine mammal entanglements for the same periods are shown in Figures 7-8. 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 2,000 days of effort in 1995. Use of gillnets north of Pt. Arguello (e.g. Monterey Bay effort) is unaffected by this closure but is subject to other California Dept. of Fish and Game restrictions[3].

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, CA and in the Monterey Bay area (principally the north portion).

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

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[3] **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)].

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 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: Overall, the current number of legal permit holders for gill 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 was 20.[2]

Total effort: Total effort for these set-net fisheries is not currently estimated but effort for white sea bass and yellowtail during 1995 was estimated at 261 days (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 1.

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 purse seine fisheries.**[4]
Note: This category includes purse seine fisheries for anchovy, mackerel, 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 150 for these fisheries. There is, currently, no legal limit on the number of permit holders.

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

**Appendix 1. Fishery Descriptions**

Number of active permit holders: Based on most recent list of fisheries in the Federal Register, an estimated 150 vessels/persons participate in this fisheries. For mackerel, there are an estimated 25 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 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 and purse seine techniques

Regulations: This fishery is managed by the California Dept. of Fish and Game in accordance with state and federal laws.

Management type: The mackerel fishery is a quota fishery but no closure has been required by the State of California for the past 10 years

Comments: Typically, anchovy is targeted for bait and mackerel is typically destined for canning overseas.

**Category II, WA Puget Sound Region salmon drift gillnet fishery.**[5]
Note: This fishery includes all inland waters south of the US-Canada Tagoosh line--Treaty Indian fishing is excluded. Previously there was an estimated 1,044 vessels/persons in this fishery.

Number of permit holders: The number of permit holders in this fishery was 966 in 1995. The number of permits renewed through mid-August 1996 was 323. Permits are being bought out.

Number of active permit holders: The number of active permit holders is unknown but was estimated at between 571 and 966 in 1995.

Total effort: Preliminary data received from the State of Washington indicates that 571 vessels made a total of 3,328 landings in the Puget Sound salmon gillnet fishery in 1995.

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 (Figure 11).

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; 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

[5] Descriptions of Category II and III Washington and Oregon fisheries were received from the Northwest Region, NMFS.

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 Salmon Commission management regimes and the ocean salmon management objectives of the Pacific Fishery Management Council.

Comments: Observers were placed onboard vessels in this fishery to monitor marine mammal and seabird interactions with this fishery in 1993 and 1994. Marine mammal interactions have been documented with: harbor porpoise, Dall's porpoise, California sea lions, and harbor seals. Take of harbor porpoise was observed whereas takes of Dall's porpoise and harbor seal were reported in logbooks.

**Category II, OR swordfish/blue shark surface longline fishery.**

Number of permit holders: The number of permits issued is limited. In 1995, 6 of the available 10 blue shark permits were issued; the number dropped to 2 in 1996. Nine of the available 20 swordfish permits were issued in 1995; the number issued dropped to 1 in 1996.

Number of active permit holders: Six blue shark permits and no swordfish permit holders are estimated to have been active. Actual values not known.

Total effort: In 1995 there were 821 pounds of blue shark landed, and no reported swordfish landings using longline gear. In 1996, (through August) there were 1068 pounds of blue shark landed, and no reported swordfish landings using longline gear.

Geographic range: This fishery occurs off the coast of Oregon. There are no area restrictions for shark longline gear, however, swordfish longlines may not be fished within 25 nautical miles of the mainland.

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. 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.

**Appendix 1. Fishery Descriptions**

**Category III, CA herring purse seine fishery.**[6]
There are 26 permittees fishing for herring who use round haul nets and over 300 permittees using gillnets with stretched mesh size less than 2.5 inches. This is a limited entry fishery with an overall quota. Of the overall quota, 25% is allocated to the round haul portion of the fleet. Of this 25%, a specific quota is allocated to each fisherman using round haul gear. The portion of the fleet using gillnets is subject to a derby style fishery rather than individual quotas. Effort using round haul nets is confined to San Francisco Bay; gillnets are used there and in Tomales Bay and near Crescent City. Typically marine mammal interaction consists of California sea lions feeding within the confines of the round haul net. As the net is drawn up, the sea lions leave.

**Category III, CA squid purse seine fishery.**[7]
The California squid purse seine fishery is an unlimited entry fishery. The total number of active fishing vessels in this fishery is unknown but in the Monterey Bay area, there are 6-9 active vessels and in southern California, the number of vessels was approximately 65 during 1995. The Monterey Bay purse seine fishery for squid is heavily regulated. The season typically opens from April - May to October - November. It is closed weekends and from noon to midnight during the season. In this region, there is a great problem with California sea lions feeding on pursed catch as fishermen typically use lights to attract squid. However, few sea lions wash up onshore in this area. There is an influx of boats into the southern California squid purse seine fishery from out-of-state. The season in this region is typically Fall to Spring; most of the effort occurs in the Santa Barbara Channel and around Catalina Island. Pilot whales have been killed in this fishery.[8] Limited entry regulation is being sought by commercial fishermen. [This fishery was reclassified as a Category II fishery in the 1997 NMFS/MMPA List of Fisheries.]

**Category III, WA Willapa Bay salmon drift gillnet fishery.**

Number of permit holders: The number of permit holders in this fishery was 300 in 1995. The number of permits renewed for this fishery through the end of August 1996 was 207. Vessels permitted to fish in the Willapa Bay were also permitted to fish in the lower Columbia River drift gillnet fishery. The number of permits issued for this fishery is being reduced through a permit buyback program.

Number of active permit holders: The number of active permit holders was approximately 167 in 1995.

Total effort: Preliminary data received from the State of Washington indicates that 167 vessels made a total of 1929 landings in the Willapa Bay salmon gillnet fishery in 1995.

Geographic range: This fishery includes all inland marine waters of Willapa Bay. The waters of the Bay are further divided into smaller statistical catch areas.

Seasons: Seasonal openings coincide with local salmon run timing and fish abundance.

Gear type: Fishing gear used in this fishery is a drift gillnet of single web construction, not exceeding 250 fathoms in length, with a minimum stretched mesh size ranging upward from 5 inches depending on target salmon species. The gear is commonly set during periods of low and high slack tides. It is the intention of the fisher to keep the net off the bottom. The vessel is attached to one end of the net and drifts with the net. The entire net is periodically retrieved onto the vessel and catch is removed. Drift times vary depending on fishing area, tidal condition, and catch.

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[6] Pers. Comm. Diana Watters, CDFG biologist.

[7] Pers. Comm. Jerry Spratt and Christine Barsky, CDFG Biologists.

[8] Miller, D.J., Herder, M.J., and Scholl, J.P. 1983. California marine mammal-fishery interaction study, 1979-1981. Southwest Fisheries Science Center Admin. Rep. LJ-83-13C. 233pp.

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.  Take of harbor seal was reported in logbooks.  Take of northern elephant seal was reported via personal communications.  This fishery has stable or decreasing effort.  No new permits have been sold and the limit will not be increased.[9]

**Category III, WA Grays Harbor salmon drift gillnet fishery.**

Number of permit holders: The number of permit holders in this fishery was 117 in 1995.  The number of permits renewed through the end of August 1996 was 51.  Vessels permitted to fish in Grays Harbor are also permitted to fish in the lower Columbia River salmon drift gillnet fishery.  The number of permits issued for this fishery is being reduced through a permit buyback program.

Number of active permit holders: The number of active permit holders was approximately 53 during 1995.

Total effort: Preliminary data received from the State of Washington indicates that 53 vessels made a total of 362 landings in the Grays Harbor salmon drift gillnet fishery in 1995.

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.  Take of harbor seal was observed.

**Category III, WA, OR lower Columbia River salmon drift gillnet fishery.**

Number of permit holders: The total number of permit holders was 747 (417 from Washington and 330 from Oregon) in 1995.  The number of permits renewed through the end of August 1996 was 258 in Washington and 231 in Oregon. Vessels may have permits from both states.

Number of active permit holders: Approximately 246 in the mainstream fishery.

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[9] Pers. Comm. Brent Norberg, NMFS.

**Appendix 1. Fishery Descriptions**

Total effort: In the mainstream fishery, 110 vessels made a total of 246 landings in 1995. In Youngs Bay (a terminal fishery), 183 vessels made a total of 1772 landings in 1995.

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 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 or trammel 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 under the Columbia River Compact.

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 have been documented.

**Category III, WA, OR salmon net pens.**

Number of permit holders: There were 12 salmon net pen ("grow out" ) facilities licensed in Washington in 1996. There are no commercial salmon net pen or aquiculture facilities currently licensed in Oregon. The term salmon net pens is a misnomer in the state of Oregon where the facilities temporarily hold salmon. Oregon currently has about 4 such facilities.

Number of active permit holders: Twelve salmon net pen facilities in Washington and four non-commercial temporary holding pens in Oregon.

Total effort: The 12 licensed facilities on Washington operate year-round; the Oregon facilities may have minor releases of 300,000 - 400,000 salmon.[10]

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

[10] Pers. Comm. Randy Reeve, Oregon Fish and Wildlife biologist.

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. In Oregon, the fishery is managed by the Procreative Division of the Oregon 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 have been reported. Interactions typically involve pinnipeds trying to enter a holding pool.

**Category III, WA, OR, CA groundfish trawl.**
Approximate number of vessels/persons: 585. Incidental takes of Steller sea lion, northern fur seal, Pacific white-sided dolphin, Dall's porpoise, California sea lion and harbor seal have been documented. Take of Dall's porpoise was observed. Take of CA sea lion and harbor seal were reported in logbooks.

The following is a description of the Pacific whiting (hake) trawl fishery which is a component of the west coast groundfish trawl fishery. It does not represent the total fishery.

Number of permit holders/active permit holders: Any vessel with a federal limited entry trawl permit may fish for whiting, but the number of vessels that do so is much smaller than the number of permits. In 1995, approximately 63 vessels made commercial landings of whiting during the regular season (9 catcher/processors and approximately 54 catcher vessels delivering to shore side or to mother ship processing vessels).

Total effort: In 1995, a total of 176,107 mt of whiting were caught by the at-sea and shore-based vessels (102,159 mt at sea, and 73,950 mt shore side). The at-sea processing fishery lasted 20 days, whereas the shore-based fishery continued until late July.

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: The fishery usually begins in the spring and continues until the quota is taken.

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: Incidental takes of Steller sea lion, northern fur seal, Pacific white-sided dolphin, Dall's porpoise, California sea lion, and harbor seal have been documented.

**Category III, Hawaii gillnet fishery.**
Approximate number of vessels/persons: 115. Interactions documented with bottlenose dolphin and spinner dolphin.

**Category III, Hawaii swordfish, tuna, billfish, mahi mahi, wahoo, and oceanic shark longline/set line fishery.**[11]

[11] Pers. Comm. Don Petersen, NMFS Observer Program.

**Appendix 1. Fishery Descriptions**

Approximate number of active vessels is 120-130. There were 167 registered vessels in 1994. This Hawaii longline fishery is active year-round and targets swordfish and tuna. Other species are typically bycatch. Effort is required to be outside of 50 nautical miles from the entire Hawaiian island chain because of possible monk seal interaction. Longlines are typically 30 miles long. Swordfish directed effort takes place during the night and fishermen use light sticks to attract squid. Tuna are targeted during daylight hours. Typically fishermen target one species per trip. Marine mammal interactions with bottlenose dolphin and false killer whale have been noted. Previous interactions with humpback whale, Risso's dolphin, and bottlenose dolphin have been documented. A limited entry program for this fishery is in place.

**Category III, Hawaii lobster trap fishery.**[12]
The number of vessels with limited entry permits was 15 in 1994; only 5 vessels fished in this year. The average number of trap-hauls per fishing day in 1994 was 847 down from 808 in 1992. Total effort in 1994 was 168,500 trap-hauls down from 721,700 in 1992. Effort is concentrated on two banks: Gardner Pinnacles and Necker Islands. Interactions are documented for Hawaiian monk seal.

**Category III, Hawaii inshore handline fishery.**
Approximate number of vessels/persons: 650. Interactions documented for bottlenose dolphin.

**Category III, Hawaii deep sea bottomfish handline and jig fishery.**
Approximate number of vessels/persons: 434. Interactions documented for Hawaiian monk seal. Effort in this fishery increases significantly around the Christmas season because a target species, a true snapper, is typically sought for cultural festivities.[11]

**Category III, Hawaii tuna handline and jig fishery.**
Approximate number of vessels/persons: 144. Interactions documented for rough-toothed dolphin, bottlenose dolphin, and Hawaiian monk seal.

[12] Dollar, R. A. 1996. Annual report of the 1994 western pacific lobster fishery, Southwest Fisheries Science Center Administrative Report, H-95-06, 33p.

**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, gill nets 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 gill nets are not allowed.

**Appendix 1.  Fishery Descriptions**

Figure 1.  Approximate location of observed drift-net sets during 7/90 - 1/96.

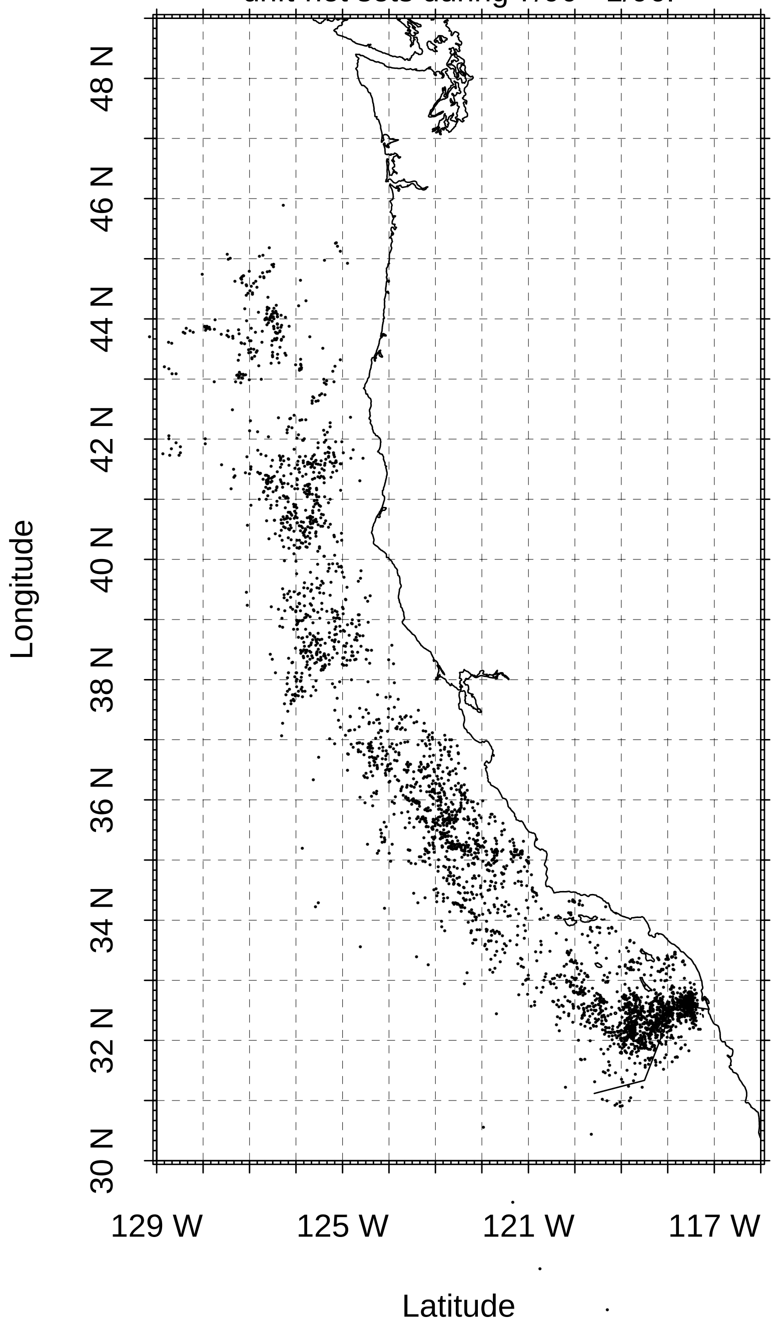


Figure 2. Approximate location of observed drift-net sets during 1995.

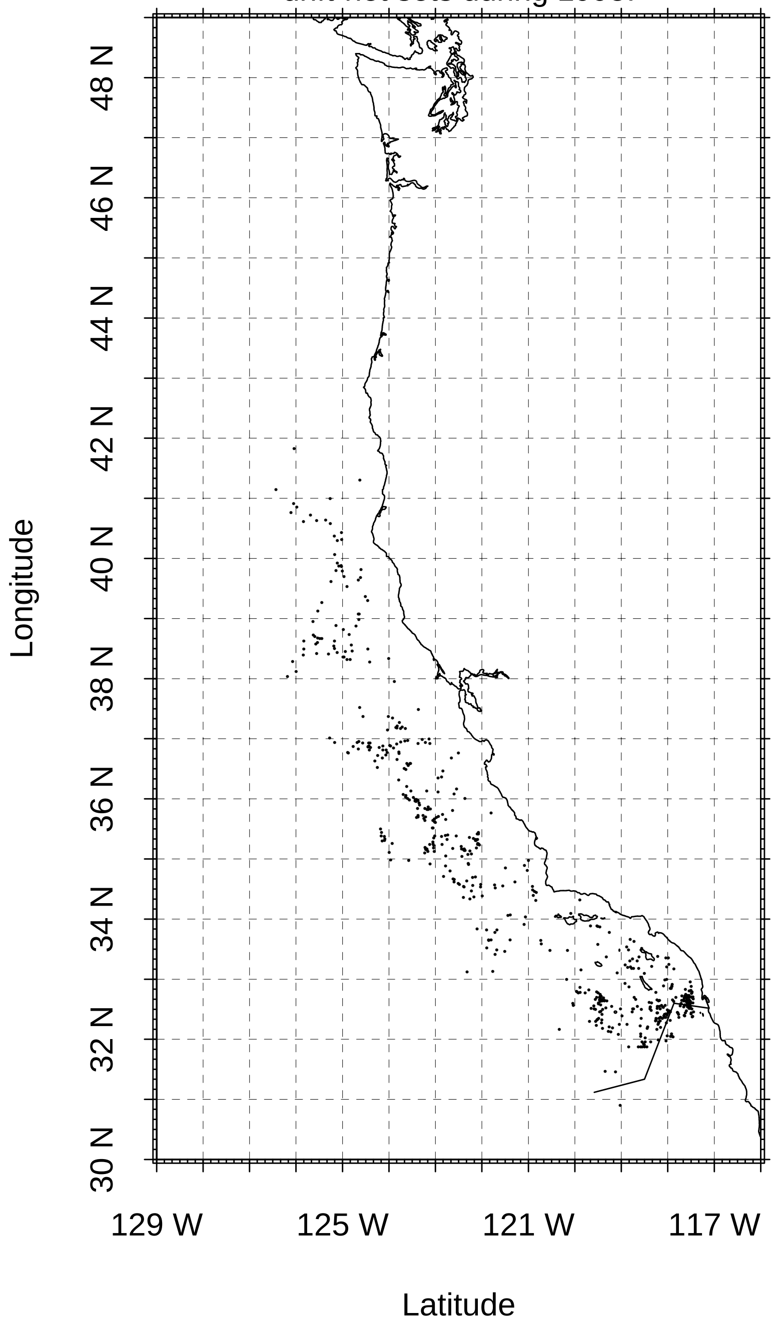


Figure 3. Location of marine mammal entanglements in the drift-net fishery during 7/90-1/96, all species.

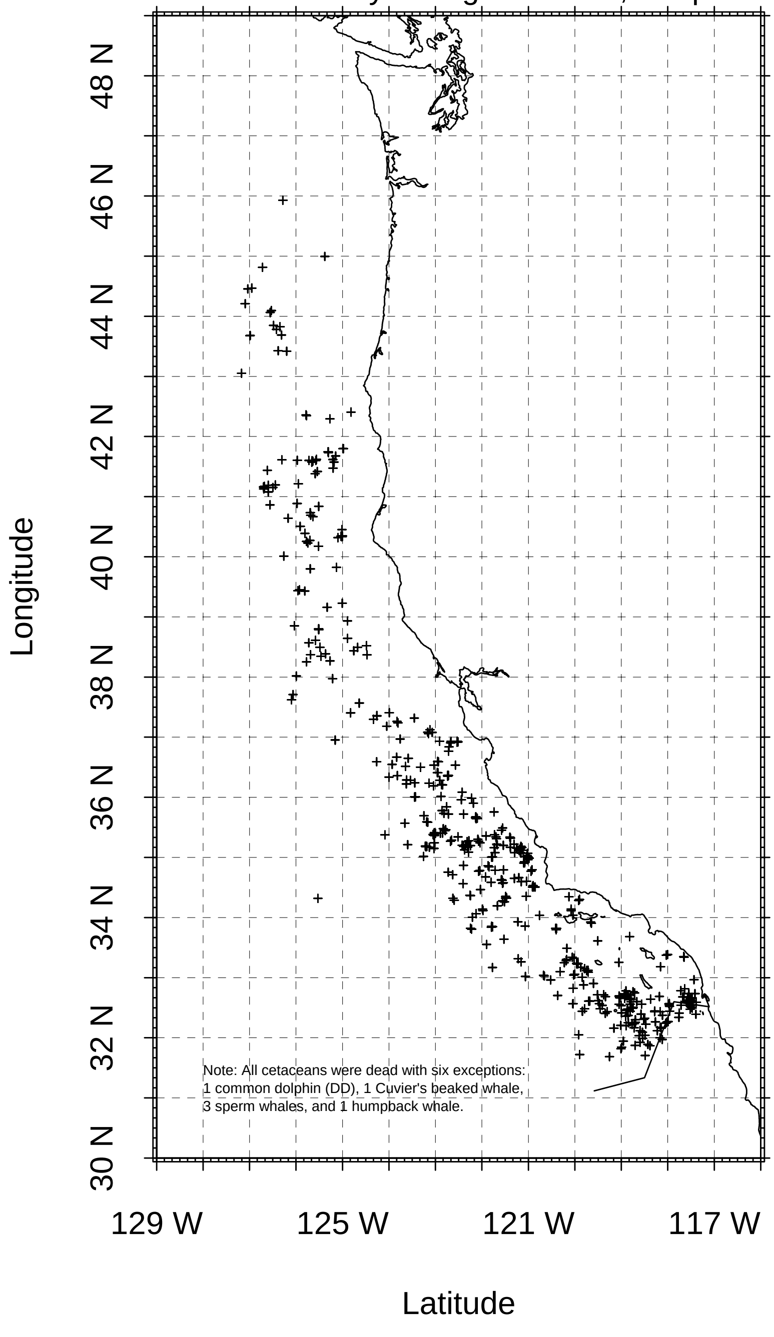


Figure 4. Location of marine mammal entanglements in the drift-net fishery during 1995, all species.

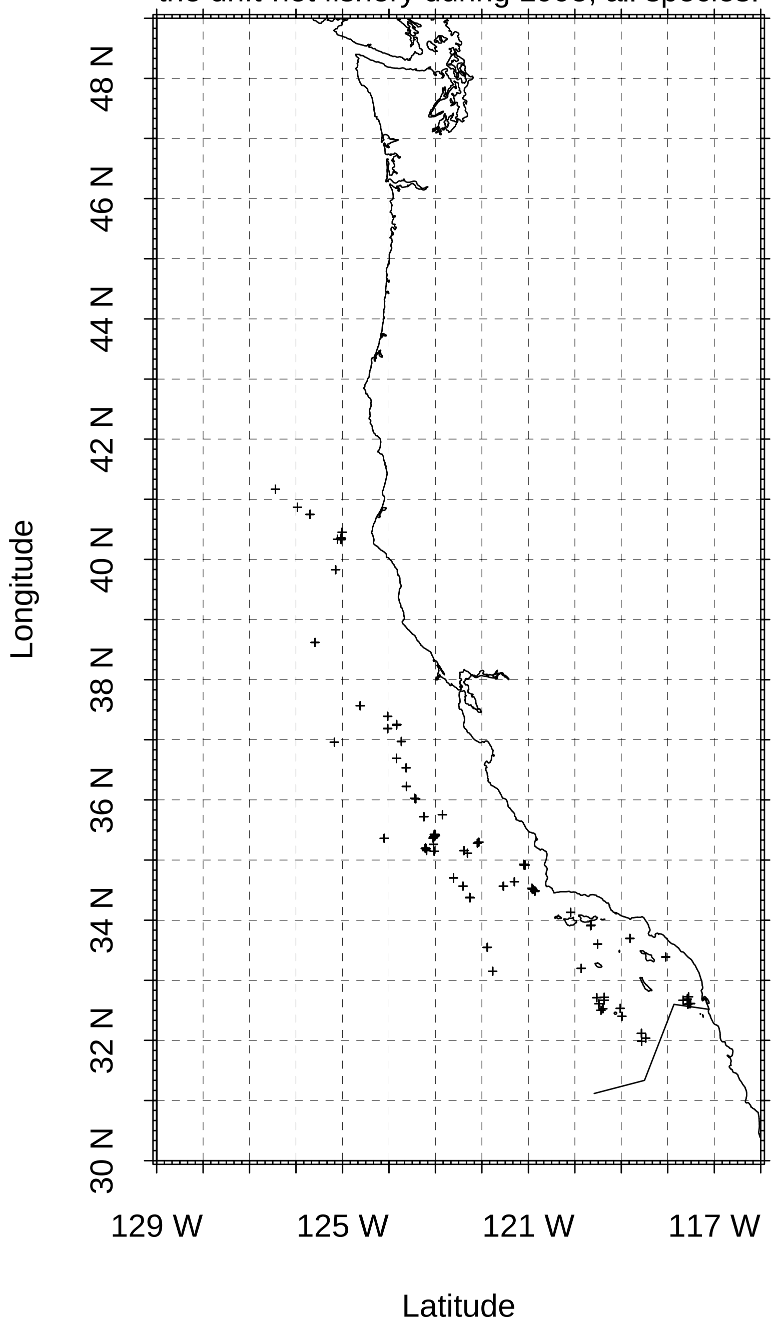


Figure 5. Approximate location of observed sets for the set-net fishery during 7/90-7/94.

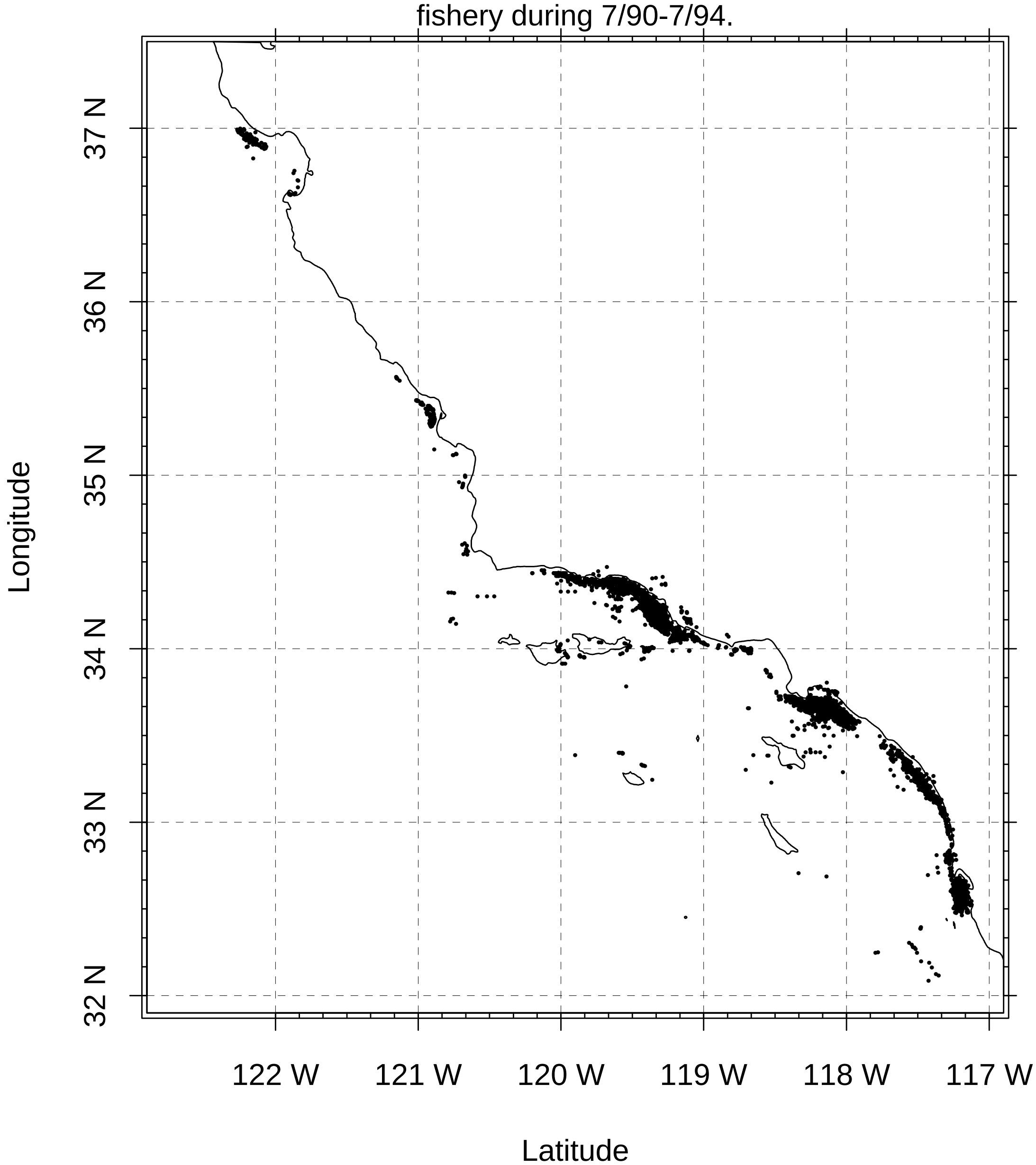


Figure 6. Approximate location of observed sets for the set-net fishery during 1994.

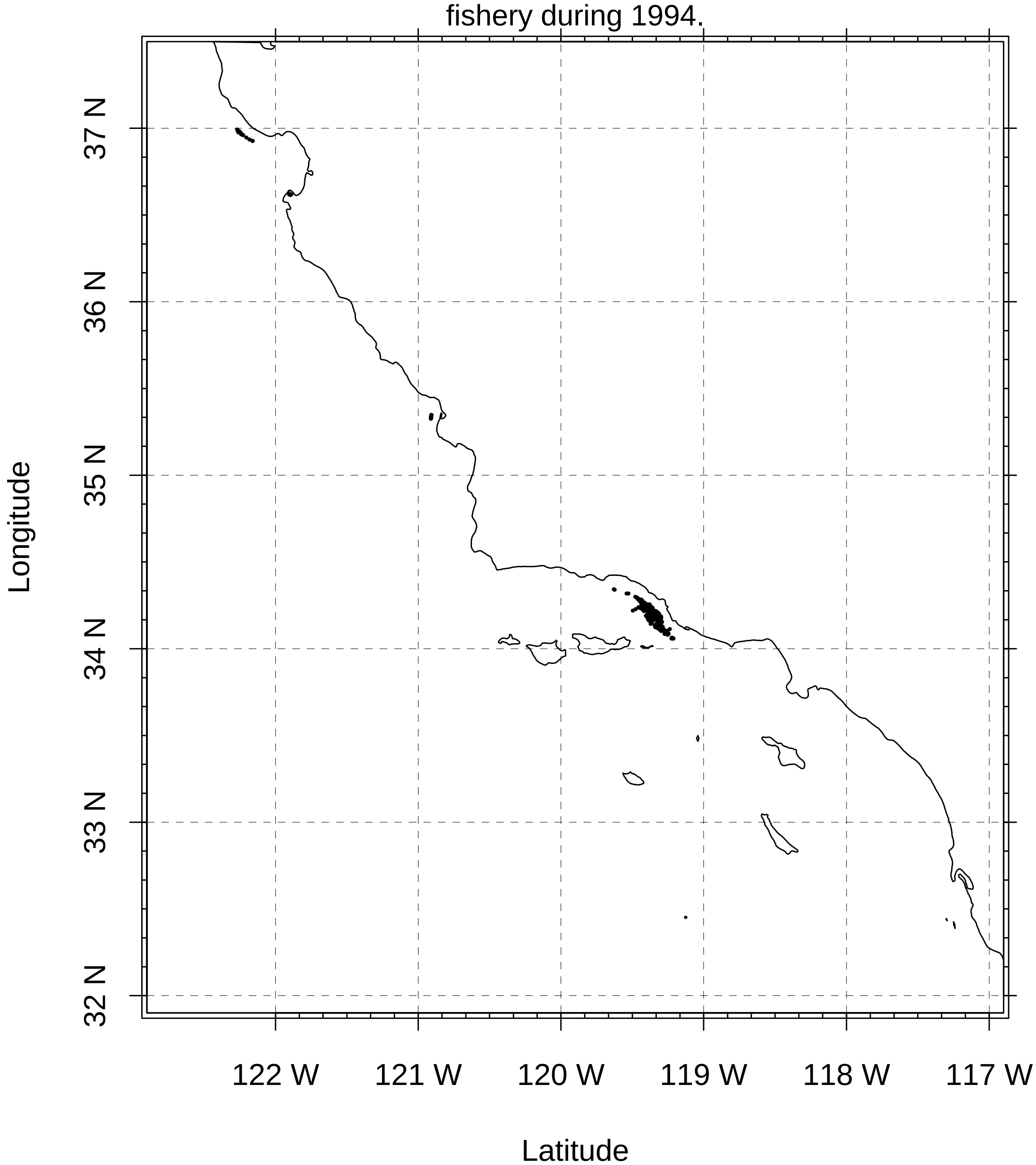


Figure 7. Location of marine mammal entanglements in the set-net fishery during 7/90 -7/94, all species

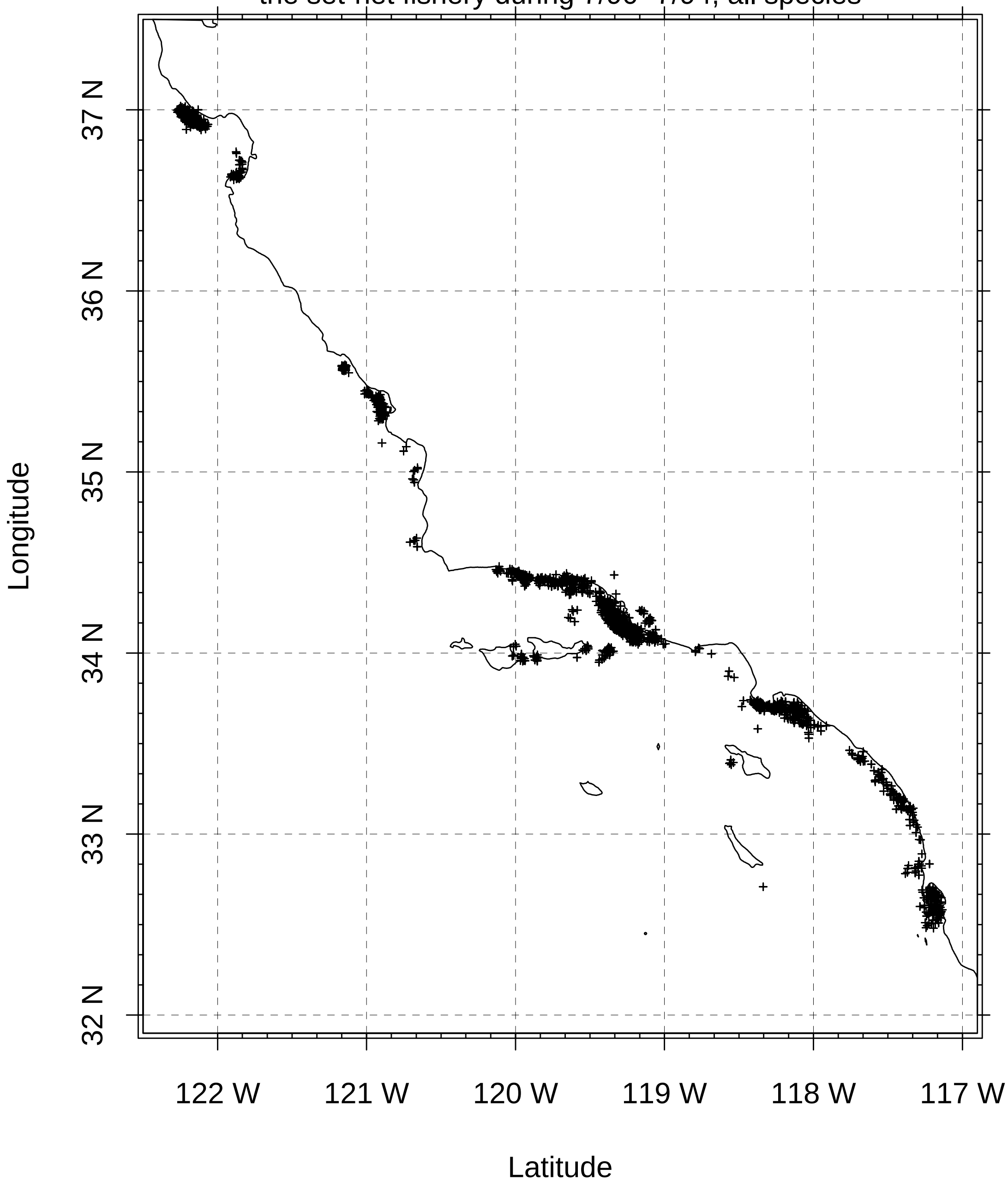


Figure 8. Location of marine mammal entanglements in the set-net fishery during 1/94 -7/94, all species

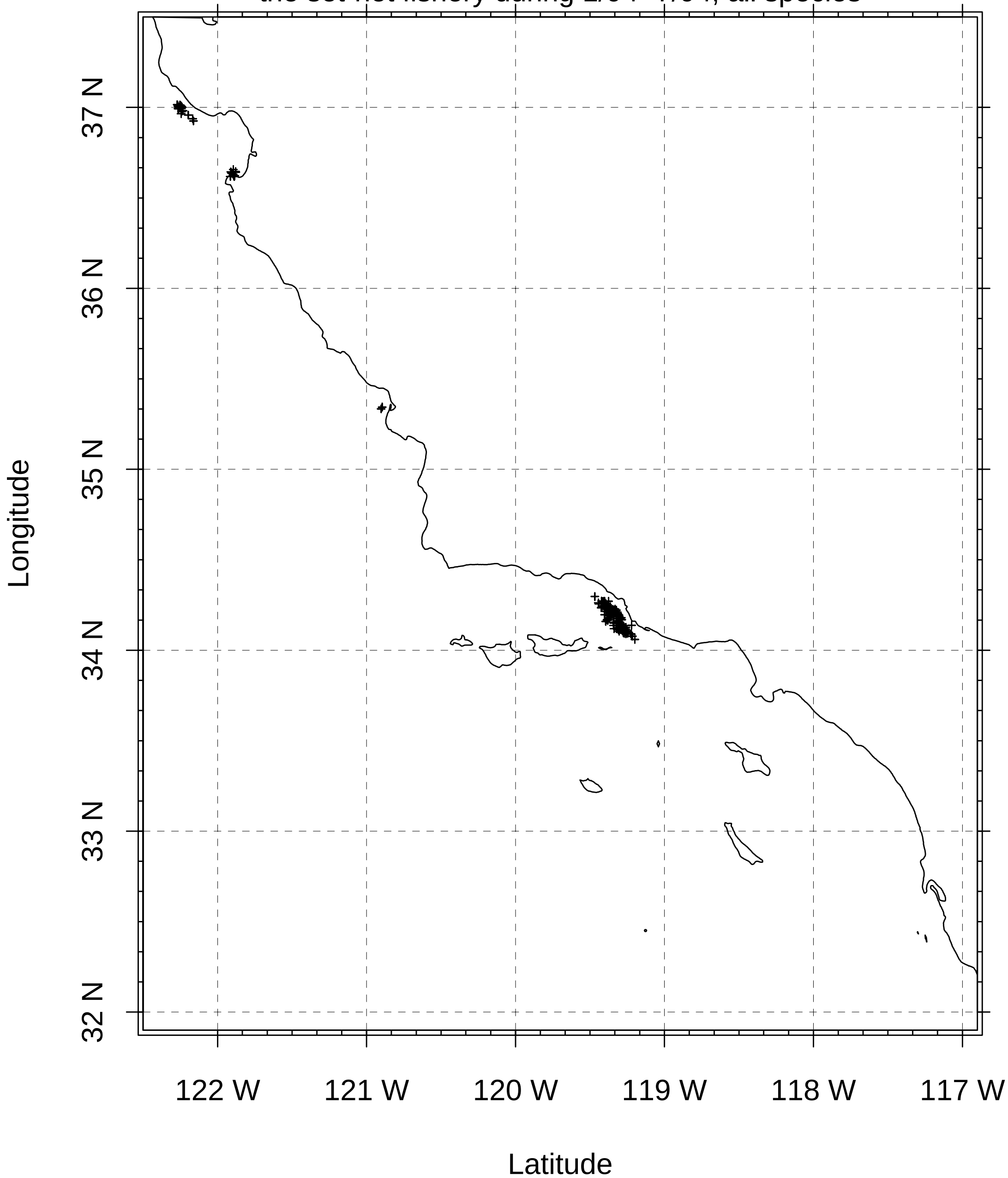


Figure 9. Drift-net fishery effort and observer coverage, 1990 - 1995. (For July-December 1990, 178 (4.4%) of 4078 days effort were observed.)

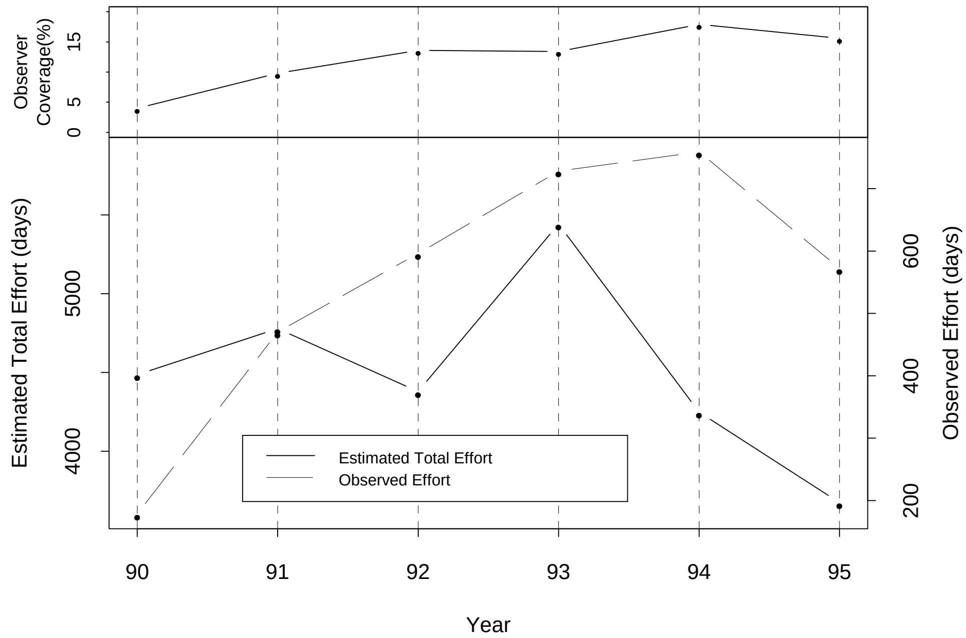



Figure 10. Set-net fishery effort and observer coverage, 1990 - 1994. (For 7/90-12
158 (5.2%) of 3041 days effort were observed, for 1/94-6/94, 142 (12.0%) of 1188 d

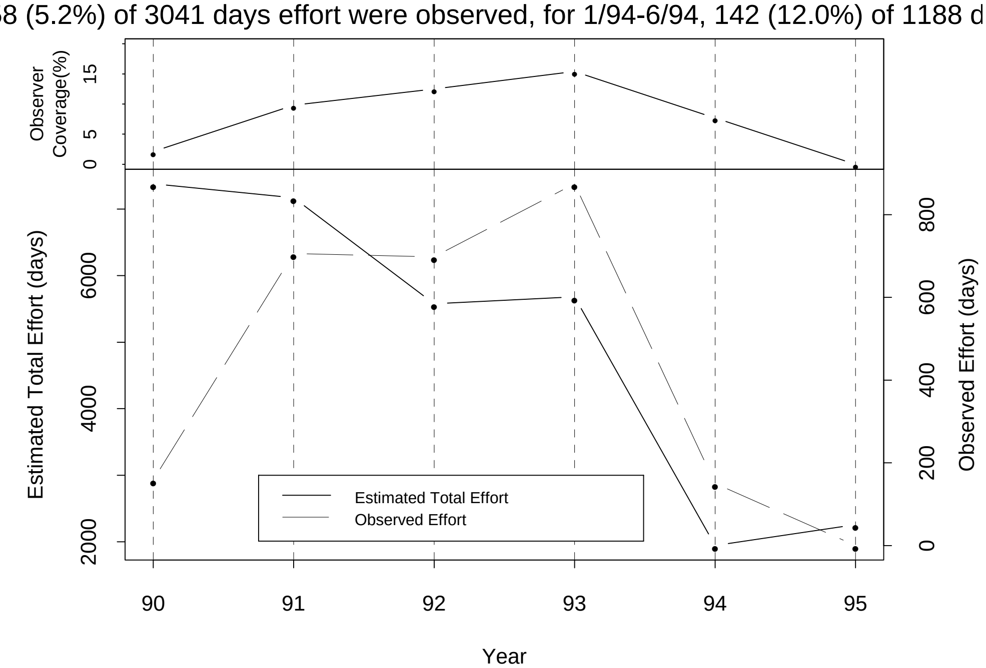
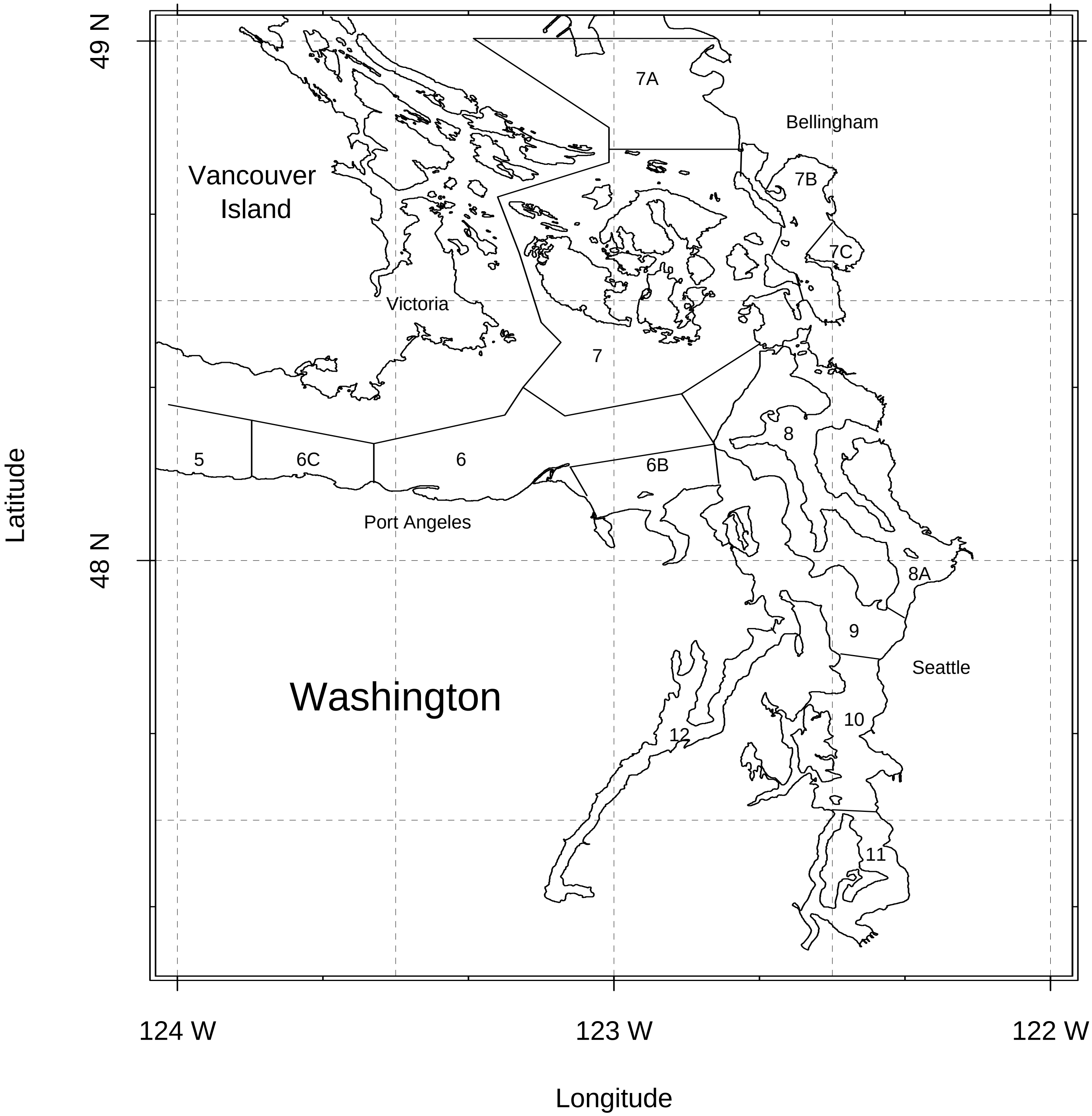


Figure 11. Statistical reporting areas for the Puget Sound Region



**Appendix 1.  Fishery Descriptions**

# Appendix 2. Cetacean Survey Effort

This appendix presents a summary of survey effort from which cetacean sighting locations were taken and plotted in stock assessment reports.

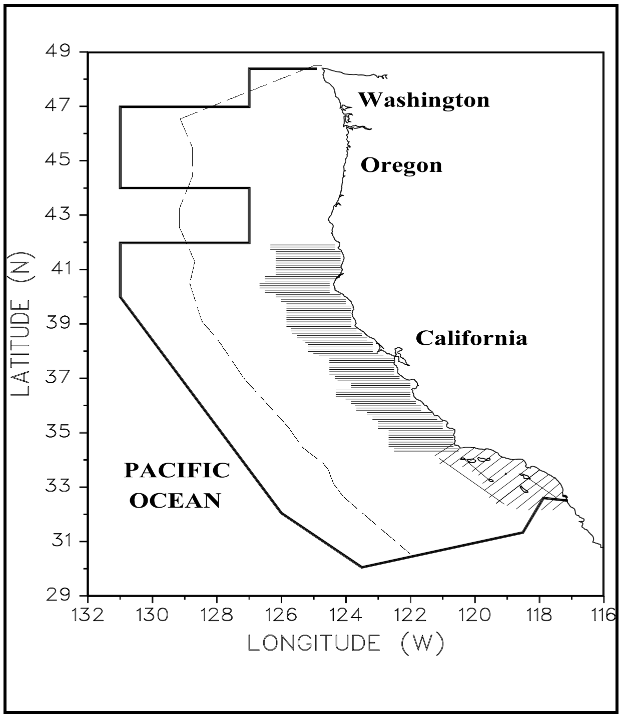



Figure 1. Transect lines surveyed during 1975-1985 year-round aerial surveys conducted by the Minerals and Management Service (Dohl et al. 1980, 1983, MMS 1993). Bold line indicates boundary of all study areas and dashed line indicates the boundary of the U.S. EEZ.

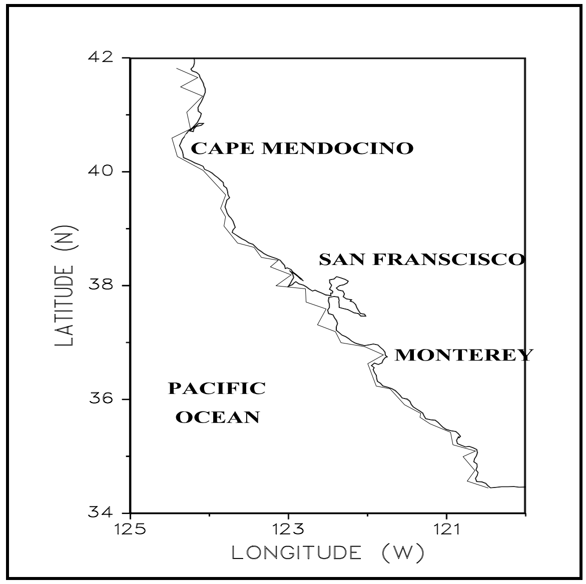



Figure 2. Transect lines surveyed during 1986-1995 NMFS harbor porpoise aerial surveys conducted in summer and fall (Forney 1995).

**Appendix 2. Summary of cetacean survey effort.**

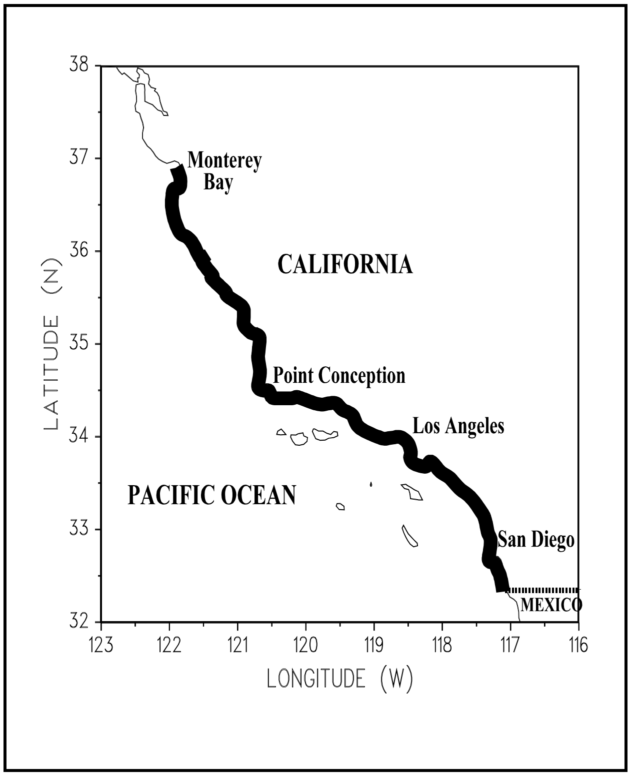



Figure 3. Coastline area (shown in bold) surveyed by NMFS/SWFSC from 1990-1994 during year-round aerial surveys of coastal bottlenose dolphins (Carretta and Forney, in prep.).

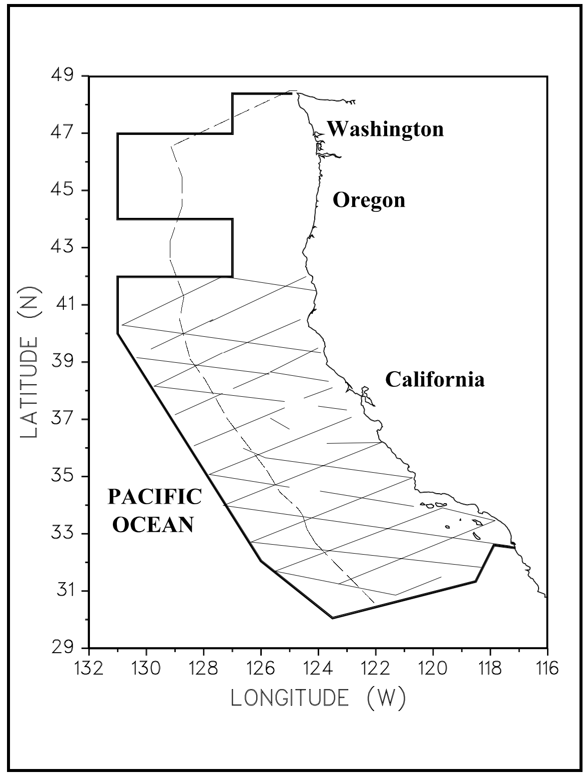



Figure 4. Transect lines surveyed during a 1991 summer/fall ship survey conducted by NMFS/SWFSC (Barlow 1995). Bold line indicates the outer boundary of all study areas and dashed line indicates the boundary of the U.S. EEZ.

**Appendix 2. Summary of cetacean survey effort.**

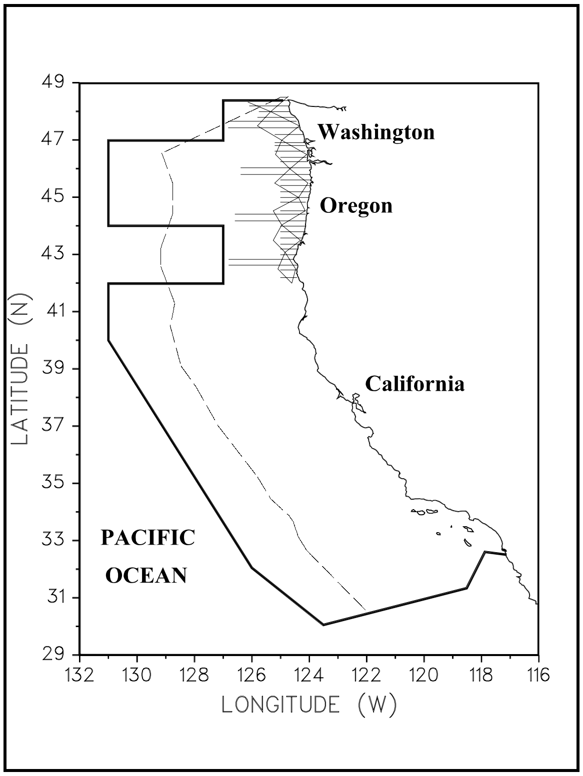



Figure 5. Transect lines surveyed during 1989-1992 year-round aerial surveys conducted by Ebasco Environmental Inc. (Green et al. 1992, 1993). Bold line indicates the outer boundary of all study areas and dashed line indicates the boundary of the U.S. EEZ.

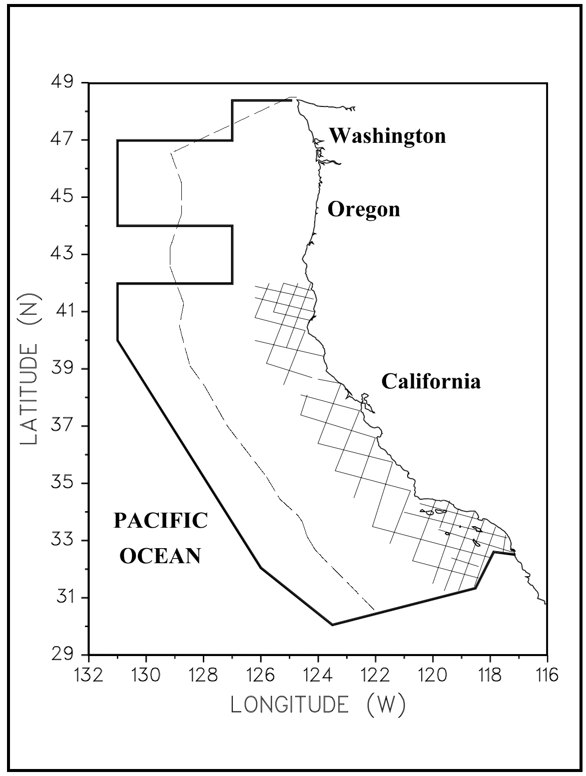



Figure 6. Transect lines surveyed during a 1991 winter/spring aerial survey conducted by NMFS/SWFSC (Forney et al. 1995). Bold line indicates the outer boundary of all study areas and dashed line indicates the boundary of the U.S. EEZ.

**Appendix 2. Summary of cetacean survey effort.**

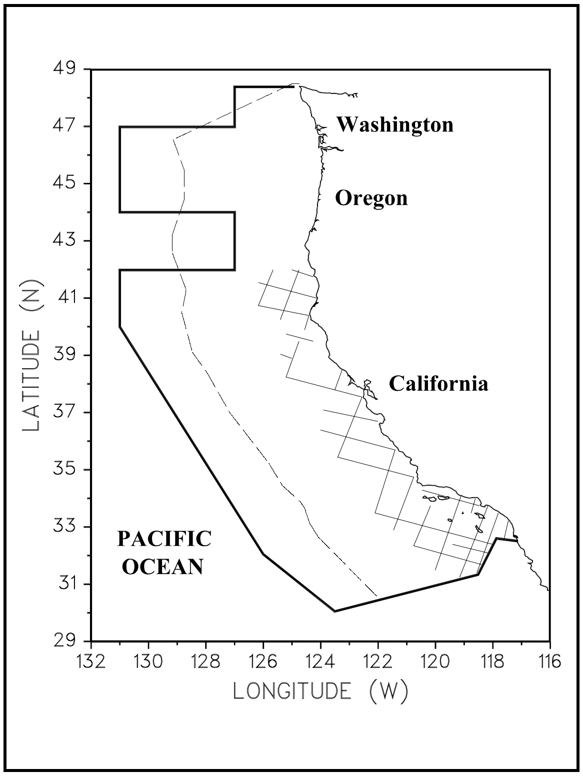



Figure 7. Transect lines surveyed during a 1992 winter/spring aerial survey conducted by NMFS/SWFSC (Forney et al. 1995). Bold line indicates the outer boundary of all study areas and dashed line indicates the boundary of the U.S. EEZ.

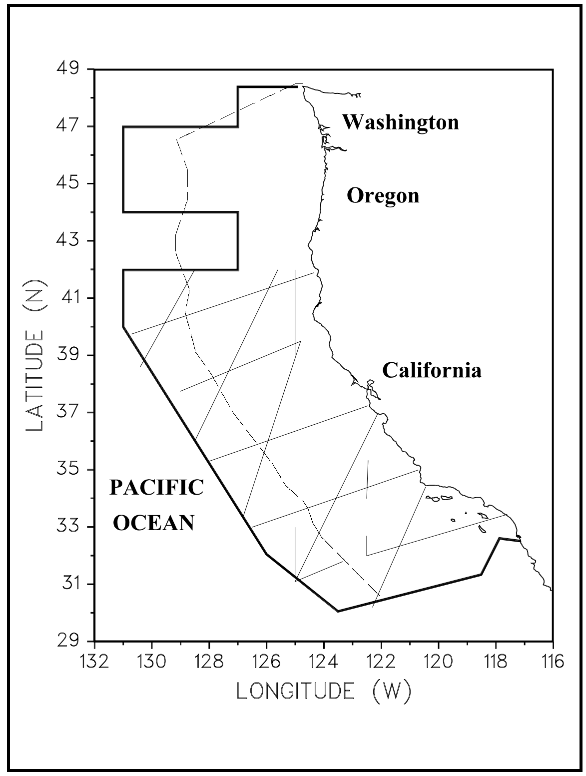



Figure 8. Transect lines surveyed during a 1993 summer/fall ship survey conducted by NMFS/SWFSC (Mangels and Gerrodette 1994). Bold line indicates the outer boundary of all study areas and dashed line indicates the boundary of the U.S. EEZ.

**Appendix 2. Summary of cetacean survey effort.**

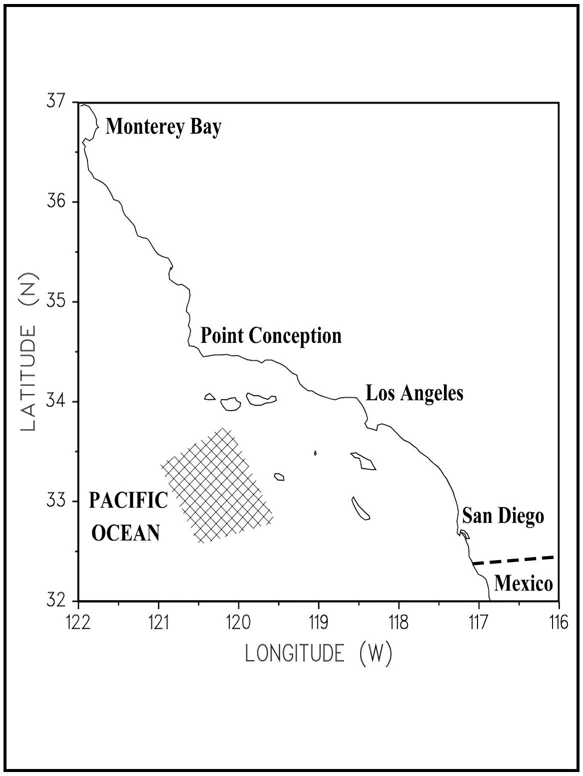



Figure 9. Transects surveyed during 1993-1994 year-round aerial surveys conducted by NMFS/SWFSC (Carretta et al. 1995).

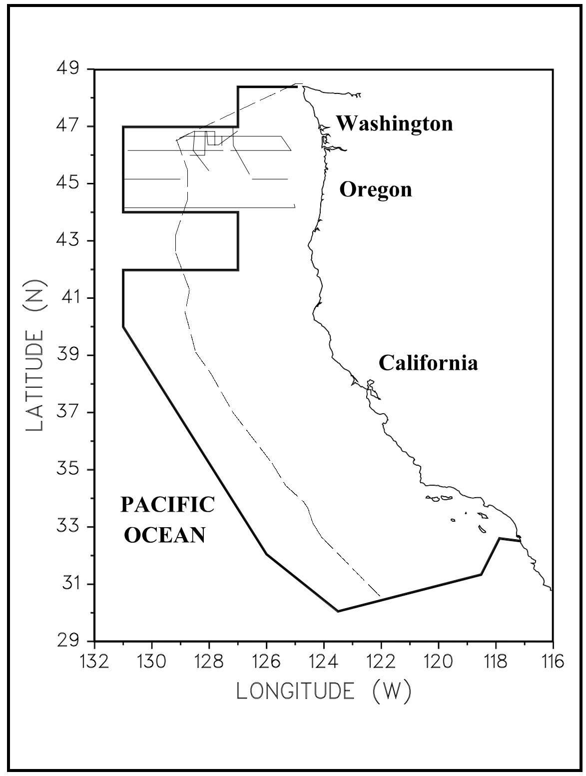



Figure 10. Transects surveyed during 1994 summer ship survey conducted by NMFS/SWFSC/NMML (NMFS, unpublished data). Bold line indicates the outer boundary of all study areas and dashed line indicates the boundary of the U.S. EEZ.

**Appendix 2. Summary of cetacean survey effort.**

## References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Carretta, J.V., K.A. Forney, and J. Barlow. 1995. Report of 1993-1994 marine mammal aerial surveys conducted within the U.S. Navy Outer Sea Test Range off southern California. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-217. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038. 90p.

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

Forney, K.A., J. Barlow, and J.V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. U.S. Fishery Bulletin 93:15-26.

Forney, K.A. 1995. A decline in the abundance of harbor porpoise, Phocoena phocoena, in nearshore waters off California, 1986-93. U.S. Fishery Bulletin 93(4):741-748.

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

Minerals Management Service. 1993. Marine Mammal and Seabird Computer Database Analysis System California OCS 1975-1985. MMS U.S. Department of the Interior Minerals Management Service Pacific OCS Region Contract #14-35-0001-30596. Prepared by Ecological Consulting Inc., Portland, Oregon, January 1993; available on CD-ROM.

National Marine Fisheries Service, Southwest Fisheries Science Center. Unpublished data.

**Appendix 3. Summary of Pacific marine mammal stock assessment reports for stocks that are under NMFS jurisdiction. N/A indicates that data are not available.**

| Species | Stock Area | Region | NMFS Center | Nmin | Rmax | Fr | PBR | Total Annual Mortality | Annual Fish. Mortality | Strategic Status |
|---|---|---|---|---|---|---|---|---|---|---|
| California sea lion | U.S. | PAC | SWC | 111,339 | 0.12 | 1.0 | 6,680 | 974 | 915 | N |
| Harbor seal | California | PAC | SWC | 27,962 | 0.12 | 1.0 | 1,678 | 243 | 234 | N |
| Harbor seal | Oregon/ Washington coast | PAC | AKC | 25,665 | 0.12 | 1.0 | 1,540 | 15 | 15 | N |
| Harbor seal | Washington inland waters | PAC | AKC | 15,349 | 0.12 | 1.0 | 921 | 36 | 36 | N |
| Northern elephant seal | California breeding | PAC | SWC | 51,625 | 0.083 | 1.0 | 2,142 | 145 | 145 | 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 | 5,018 | 0.086 | 1.0 | 216 | 0.0 | 0.0 | N |
| Hawaiian monk seal | Hawaii | PAC | SWC | 1,366 | 0.07 | 0.1 | 4.8[1] | N/A | N/A | Y |
| Harbor porpoise | Central California | PAC | SWC | 3,431 | 0.04 | 0.48 | 33 | 14 | 14 | N |
| Harbor porpoise | Northern California | PAC | SWC | 7,640 | 0.04 | 0.5 | 76 | 0.0 | 0.0 | N |
| Harbor porpoise | Oregon/ Washington coast | PAC | AKC | 22,046 | 0.04 | 0.48 | 212 | 13 | 13 | N |
| Harbor porpoise | Inland Washington | PAC | AKC | 2,681 | 0.04 | 0.4 | 21 | 15 | 15 | N |
| Dall's porpoise | California/ Oregon/ Washington | PAC | SWC | 34,393 | 0.04 | 0.48 | 330 | 22 | 22 | N |
| Pacific white-sided dolphin | California/ Oregon/ Washington | PAC | SWC | 82,939 | 0.04 | 0.48 | 796 | 22 | 22 | N |
| Risso's dolphin | California/ Oregon/ Washington | PAC | SWC | 22,388 | 0.04 | 0.5 | 224 | 37 | 37 | N |
| Bottlenose dolphin | California coastal | PAC | SWC | 134 | 0.04 | 0.5 | 1.3 | 0.0 | 0.0 | N |
| Bottlenose dolphin | California/ Oregon/ Washington offshore | PAC | SWC | 1,904 | 0.04 | 0.4 | 15 | 4.4 | 4.4 | N |
| Striped dolphin | California/ Oregon/ Washington | PAC | SWC | 19,248 | 0.04 | 0.4 | 154 | 1.2 | 1.2 | N |

## Appendix 3. Summary of Stock Assessment Report

| Species | Stock Area | Region | NMFS Center | Nmin | Rmax | Fr | PBR | Total Annual Mortality | Annual Fish. Mortality | Strategic Status |
|---|---|---|---|---|---|---|---|---|---|---|
| Common dolphin, short-beaked | California/ Oregon/ Washington | PAC | SWC | 309,717 | 0.04 | 0.5 | 3,097 | 272 | 272 | N |
| Common dolphin, long-beaked | California | PAC | SWC | 5,504 | 0.04 | 0.48 | 53 | 14 | 14 | N |
| Northern right whale dolphin | California/ Oregon/ Washington | PAC | SWC | 15,080 | 0.04 | 0.5 | 151 | 47 | 47 | N |
| Killer whale | California/ Oregon/ Washington | PAC | SWC | 436 | 0.04 | 0.4 | 3.5 | 1.20 | 1.20 | N |
| Killer whale | Southern Resident Stock | PAC | AKC | 96 | 0.04 | 1.0 | 1.9 | 0.0 | 0.0 | N |
| Pilot whale, short-finned | California/ Oregon/ Washington | PAC | SWC | 741 | 0.04 | 0.4 | 5.9 | 13 | 13 | Y |
| Baird's beaked whale | California/ Oregon/ Washington | PAC | SWC | 252 | 0.04 | 0.4 | 2.0 | 1.20 | 1.20 | N |
| Mesoplodont beaked whales | California/ Oregon/ Washington | PAC | SWC | 1,169[1] | 0.04 | 0.45 | 11[2] | 9.2-13 | 9.2-13 | Y |
| Cuvier's beaked whale | California/ Oregon/ Washington | PAC | SWC | 6,070 | 0.04 | 0.5 | 61 | 28 | 28 | N |
| Pygmy sperm whale | California/ Oregon/ Washington | PAC | SWC | 2,059 | 0.04 | 0.45 | 19 | 2.8 | 2.8 | N |
| Dwarf sperm whale | California/ Oregon/ Washington | PAC | SWC | N/A | 0.04 | 0.5 | N/A | 0.0 | 0.0 | N |
| Sperm whale | California/ Oregon/ Washington | PAC | SWC | 896 | 0.04 | 0.1 | 1.8 | 4.5 | 4.5 | Y |
| Humpback whale | California/ Oregon/ Mexico | PAC | SWC | 563 | 0.04 | 0.1 | 0.5 | 1.8 | 1.2 | Y |
| Blue whale | California/ Mexico | PAC | SWC | 1,463 | 0.04 | 0.1 | 1.5 | 0.2 | 0.0 | Y |
| Fin whale | California/ Oregon/ Washington | PAC | SWC | 747 | 0.04 | 0.1 | 1.5 | <1 | 0.0 | Y |
| Bryde's whale | Eastern Tropical Pacific | PAC | SWC | 11,163 | 0.04 | 0.5 | 0.2[3] | 0.0 | 0.0 | N |

**Appendix 3. Summary of Stock Assessment Report**

| Species | Stock Area | Region | NMFS Center | Nmin | Rmax | Fr | PBR | Total Annual Mortality | Annual Fish. Mortality | Strategic Status |
|---|---|---|---|---|---|---|---|---|---|---|
| Sei whale | Eastern North Pacific | PAC | SWC | N/A | 0.04 | 0.1 | N/A | 0.0 | 0.0 | Y |
| Minke whale | California/ Oregon/ Washington | PAC | SWC | 122 | 0.04 | 0.4 | 1.0 | 1.2 | 1.2 | Y |
| Rough-Toothed dolphin | Hawaii | PAC | SWC | N/A | 0.04 | 0.5 | N/A | 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 | 0.04 | 0.5 | N/A | N/A | N/A | N |
| Pantropical spotted dolphin | Hawaii | PAC | SWC | N/A | 0.04 | 0.5 | N/A | N/A | N/A | N |
| Spinner dolphin | Hawaii | PAC | SWC | 677 | 0.04 | 0.5 | 6.8 | N/A | N/A | N |
| Striped dolphin | Hawaii | PAC | SWC | N/A | 0.04 | 0.5 | N/A | N/A | N/A | N |
| Melon-headed whale | Hawaii | PAC | SWC | N/A | 0.04 | 0.5 | N/A | 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 | 0.04 | 0.5 | N/A | N/A | N/A | N |
| 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 | 0.04 | 0.5 | N/A | N/A | N/A | N |
| Blainville's beaked whale | Hawaii | PAC | SWC | N/A | 0.04 | 0.5 | N/A | N/A | N/A | N |
| Cuvier's beaked whale | Hawaii | PAC | SWC | N/A | 0.04 | 0.5 | N/A | 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 | 0.04 | 0.1 | N/A | 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 |

[1] This value includes a species-specific minimum abundance estimate of 249 Blainville's beaked whales, Mesoplodon densirostris.

[2] This PBR includes 2.2 Blainville's beaked whales.

[3] This PBR has been adjusted because only 0.2% of this stock is estimated to be in U.S. waters.