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Marine Mammal Stock Assessments: 1998

by

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CETACEANS - U.S. WEST COAST

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U.S. Pacific Marine Mammal Stock Assessments: 1998

The National Marine Fisheries Service (NMFS) is required to publish Stock Assessment Reports for all stocks of marine mammals within U.S. waters, to review new information every year for strategic stocks and every 3 years for non-strategic stock, and to update the stock assessment reports when significant new information becomes available. This report presents an update of information presented in the previous Stock Assessment Reports for the Pacific Region (Barlow et al. 1997), including the U.S. EEZ waters adjacent to Washington, Oregon, California, and Hawaii. Marine mammal stocks in this region include those studied by the Southwest Fisheries Science Center (La Jolla, California) and the National Marine Mammal Laboratory (Seattle, Washington) and individual reports were revised separately by personnel at those two NMFS laboratories. A summary of the revised reports is given in Appendix 1.

Stock assessment reports were revised during 1997 for five of the six stocks of marine mammals in the Pacific Region falling under jurisdiction of the National Marine Mammal Laboratory (NMML). The revised stock assessment reports from NMML include the following stocks: Oregon & Washington coastal waters harbor seal, Washington inland waters harbor seal, San Miguel Island northern fur seal, Oregon & Washington coast harbor porpoise, and inland Washington harbor porpoise. Fishery mortality sections in the revised reports have been updated to include observer program, fisher self-reporting, and stranding data through 1996, where possible. New abundance estimates are available and have been included in the revised assessments for the Oregon & Washington coastal waters harbor seal, the Washington inland waters harbor seal, San Miguel Island northern fur seal, and the inland Washington harbor porpoise stocks. New Potential Biological Removal estimates have been calculated for each stock having a revised abundance estimate. The status of these five stocks remains non-strategic.

The Southwest Fisheries Science Center reviewed new information on the status of all marine mammal stocks under their jurisdiction. New abundance and mortality estimates were available for several cetacean stocks found off the U.S. west coast, and the review of this new information is summarized in Appendix 2. The review showed that the MMPA status of the CA/OR/WA stock of minke whales and the CA/OR/WA stock of mesoplodont beaked whales should be changed from “strategic” to “non-strategic”. The Southwest Fisheries Science Center views this new information to be very significant and has therefore revised the stock assessment reports for these species (attached). No changes were made this year to the Reports for other species.

Earlier versions of these drafts were reviewed by the Pacific Scientific Review Group, the Marine Mammal Commission, the Humane Society of the United States, and by Paul Wade; we thank them for their helpful comments.

REFERENCES

Barlow, J., K. A. Forney, P. S. Hill, R. L. Brownell, Jr., J. V. Carretta, D. P. DeMaster, F. Julian, M. S. Lowry, T. Ragen, and R. R. Reeves. 1997. U.S. Pacific Marine Mammal Stock Assessments: 1996. NOAA Technical Memorandum NOAA-TM-NMFS-SWFC-248. 223pp.

Revised 12/15/98

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

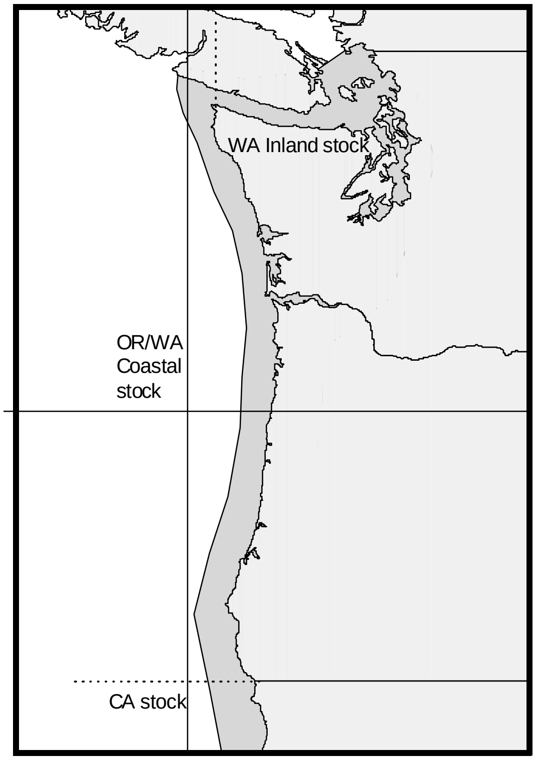

Figure 1. Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

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

POPULATION SIZE

Aerial surveys of harbor seals in Oregon and Washington were conducted by personnel from the National Marine Mammal Laboratory (NMML) and the Oregon and Washington Departments of Fish and Wildlife (ODF&W and WDF&W) during the 1996 pupping season. Total numbers of hauled-out seals (including pups) were counted during these surveys. In 1996, the mean count of harbor seals occurring along the Washington coast was 10,685 (CV=0.011) animals (Jeffries et al. 1997). In 1996, the mean count of harbor seals occurring along the Oregon coast and in the Columbia River was 6,421 (CV=0.042) animals (Brown 1997, Jeffries et al. 1997). Combining these counts results in 17,106 (CV=0.017) harbor seals in the Oregon and Washington Coast stock.

Radio-tagging studies conducted at 6 locations (3 Washington inland waters sites and 3 Oregon and Washington coastal sites) collected information on haulout pattern from 63 harbor seals in 1991 and 61 harbor seals in 1992. Data from coastal and inland sites were not significantly different and were thus pooled, resulting in a correction factor of 1.53 (CV=0.065) to account for animals in the water which are missed during the aerial surveys (Huber 1995). Utilizing this correction factor results in a population estimate of 26,172 (17,106 x 1.53; CV=0.067) for the Oregon and Washington Coast stock of harbor seals in 1996 (Jeffries et al. 1997).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/exp(0.842*[ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 26,172 and its associated CV(N) of 0.067, N_{MIN} for this stock is 24,733.

Current Population Trend

Historical levels of harbor seal abundance in Oregon and Washington are unknown. The population apparently decreased during the 1940s and 1950s due to bounty hunting. Approximately 17,133 harbor seals were killed in Washington by bounty hunters between 1943 and 1960 (Newby 1973). More than 3,800 harbor seals were killed in Oregon between 1925 and 1972 by a state-hired seal hunter, as well as bounty hunters (Pearson 1968). The population remained relatively low during the 1960s, but since the termination of the harbor seal bounty program and protection provided by the Marine Mammal Protection Act (MMPA) harbor seal counts for this stock have increased from 6,389 in 1977 to 17,106 in 1996 (H. Huber unpubl. data, S. Jeffries unpubl. data, R. Brown unpubl. data).

Between 1983 and 1996, the annual rate of increase for this stock was 4%, with the peak count of 18,667 seals occurring in 1992. Since 1991, however, this stock has declined 1.6% (t=3.25; p=0.083) annually (Jeffries et al. 1997), which may indicate that this population has exceeded equilibrium levels. Analyzing only the Oregon data (average annual rate of increase was 0.3% from 1988-96) indicates that the Oregon segment of the stock may be approaching equilibrium (Brown 1997). It is possible that the lower total counts for the population as a whole may have resulted from changes in haulout behavior. Increased disturbance, reduced food availability necessitating longer foraging periods, or other unknown reasons may have caused a larger number of seals to be in the water during the surveys (Jeffries et al. 1997).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

From 1978 to 1993, counts of harbor seals throughout Washington state increased at an annual rate of 7.68% (Huber 1995). The Oregon and Washington Coast harbor seal stock increased at an annual rate of 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for stocks thought to be within OSP (Wade and Angliss 1997). Thus, for the Oregon and Washington Coast stock of harbor seals, PBR = 1,484 animals (24,733 x 0.06 x 1.0).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

With the exception of 1994, NMFS observers monitored the northern Washington marine set gillnet fishery during 1990-1996 (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 Coast and Inland Washington stocks) occurring in Washington State waters. Some of the animals taken in the inland waters portion of the fishery (see stock assessment report for the Inland Washington stock for details) may have been animals from the coastal stock. Similarly, some of the animals taken in the coastal portion of the fishery may have been from the inland stock. For the purposes of this stock assessment report, the animals taken in the inland portion of the fishery are assumed to have belonged to the Inland Washington stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon/Washington Coast stock. However, as noted, some movement of animals between Washington's coastal and inland waters is likely, although data from tagging studies have not shown movement of harbor seals between the two locations (Huber 1995). Accordingly, Table 1 includes data only from that portion of the northern Washington marine set gillnet fishery occurring within the range of the Oregon and Washington Coast stock (those waters south and west of Cape Flattery). Data from 1990-96 are included in the table, although the mean estimated annual mortality is calculated using only the most recent 5 years for which data are available. 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 for this fishery is 5.6 (CV=.33) harbor seals per year from this stock.

The WA/OR/CA groundfish trawl fishery (Pacific whiting component) was monitored for incidental take during 1990-96. The only harbor seal mortality occurred in 1996, a year in which observer coverage (based on observed tons) was 65%. The observed mortality occurred during an unmonitored haul and therefore was not used to estimate mortality for the entire fishery. Although coverage was 65%, observers monitored 100% of the vessels during the fishery. As a result, the reported mortality is thought to be the only harbor seal mortality in that fishery. The mean estimated mortality from 1992-96 for this fishery is 0.2 (CV=1.0) harbor seals per year from this stock.

Table 1. Summary of incidental mortality of harbor seals (Oregon and Washington Coast stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1992 to 1996 (or the most recent 5 years of available data) are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. 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	90-96	obs data	68-100%	5, 7, 0, n/a, n/a, 3, 9	6, 10, 0, n/a, n/a, 3, 9	5.6 (CV=.33)
WA/OR/CA groundfish trawl (Pacific whiting component)	90-96	obs data	44-72%	0, 0, 0, 0, 0, 0, 1	0, 0, 0, 0, 0, 0, 1	0.2 (CV=1.0)
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
Observer program total						12.5 (CV=.31)
				Reported mortalities		
WA Willapa Bay drift gillnet	90-96	self reports	n/a	0, 0, 6, 8, n/a, n/a, n/a	n/a	[≥3.5]
WA/OR salmon net pens	90-96	self reports	n/a	0, 2, 0, 0, n/a, n/a, n/a	n/a	[≥0.5]
Minimum total annual mortality						≥16.5 (CV=.31)

The Washington and Oregon Lower Columbia River drift gillnet fishery was monitored during 1991-93 (Brown and Jeffries 1993, Matteson et al. 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 was observed incidental to the fishery. The observed effort was 518 sets, representing an observer coverage of 4.6%. Due to the reduced sampling regime, the mortality was not extrapolated to estimate total kill for the fishery in 1993. Using only the 1991-92 data, the mean estimated mortality for this fishery is 213 (CV=0.10) harbor seals per year. However, fishing effort has been dramatically reduced since the 1991-92 fishing seasons. For instance, during 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.

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 northern Washington marine set gillnet (5.6), WA/OR/CA groundfish trawl (0.2), and Washington Grays Harbor salmon drift gillnet (6.7) fisheries results in an estimated mean mortality rate in observed fisheries of 12.5 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 mortalities were self-reported by fishers in 1992 and 1993, the low level of observer coverage failed to document harbor seal mortalities which had apparently occurred. Due to the low level of observer coverage for this fishery, the self-reported fishery mortalities have been included in Table 1 and represent a minimum mortality estimate resulting from that fishery (3.5 harbor seals per year).

An additional source of information on the number of harbor seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1996, fisher self-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 (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are not available for 1994 and 1995, and considered unreliable for 1996 (see Appendix 4 of Hill and DeMaster, in press).

Other Mortality

Strandings of harbor seals resulting from collisions with boats, from gunshot injuries, or entangled in line unrelated to fisheries are another source of mortality data. During the 5-year period from 1992 to 1996 the only human-related harbor seal strandings of animals from this stock occurred in 1993 (5 animals) and 1994 (4 animals), resulting in an estimated annual mortality of 1.6 harbor seals (rounded to 2) from this stock during 1992-96. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

Subsistence Harvests by Northwest Treaty Indian Tribes

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

STATUS OF STOCK

Harbor seals are not considered as “depleted” under the MMPA or listed as “threatened “ or “endangered” under the Endangered Species Act. Based on currently available data, the level of human-caused mortality and serious injury (17+2=19) does not exceed the PBR (1,484). Therefore, the Oregon and Washington Coast stock of harbor seals is not classified as a strategic stock. The minimum total fishery mortality and serious injury for this stock (17; based on observer data (13) and self-reported fisheries information (4) where observer data were not available or failed to detect harbor seal mortality) is also less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The stock size increased until 1992, but has declined in recent years. Evidence indicates this stock is likely within OSP (Jeffries et al. 1997), although quantitative analyses in support of this have not yet been completed.

REFERENCES

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

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

Boveng, P. 1988. Status of the Pacific harbor seal population on the U.S. west coast. Southwest Fisheries Center, NMFS. Admin. Rept. LJ-88-06. 43 pp.

Brown, R. F., Oregon Department of Fish and Wildlife, Marine Science Dr., Bldg. 3, Newport, OR, 97365.

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

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

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

Brown, R. F., and S. J. Jeffries. 1993. Preliminary report on estimated marine mammal mortality in Columbia River Fall and Winter Salmon Gillnet Fisheries, 1991-1992. Unpubl. Rpt., Columbia River Area Gillnet Fishery Observer Program, 13 pp. Available at Oregon Dept. Fish and Wildl., Newport, OR, 97365.

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

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

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

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

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

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

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

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

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

Hill, P. S, and D. P. DeMaster. (In press). Alaska marine mammal stock assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC.

Huber, H., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA, 98115.

Huber, H. 1995. The abundance of harbor seals (*Phoca vitulina richardsi*) in Washington, 1991-1993. MS Thesis, Univ. of Washington, Seattle, Washington. 56 pp.

Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1993. Abundance of harbor seals (*Phoca vitulina richardsi*) in Washington and Oregon, 1992. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1994. Harbor seal stock assessment in Washington and Oregon

1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Jeffries, S. J., Washington Department of Fish and Wildlife, Marine Mammal Investigations, 7801 Phillips Rd. SW, Tacoma, WA, 98498.

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

Jeffries, S. J., R. F. Brown, H. R. Huber, and R. L. DeLong. 1997. Assessment of harbor seals in Washington and Oregon 1996. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

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

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

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

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

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

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

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

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

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

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

Pearson, J. P. 1968. The abundance and distribution of harbor seals and Steller sea lions in Oregon. MS Thesis, Oregon State Univ., Corvallis, Oregon. 23 pp.

Pitcher, K. W., and D. G. Calkins. 1979. Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 19(1983):231-310.

Pitcher, K. W., and D. C. McAllister. 1981. Movements and haul out behavior of radio-tagged harbor seals, *Phoca vitulina*. Can. Field Nat. 95:292-297.

Scheffer, V. B., and J. W. Slipp. 1944. The harbor seal in Washington state. Amer. Midl. Nat. 32:373-416.

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

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

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

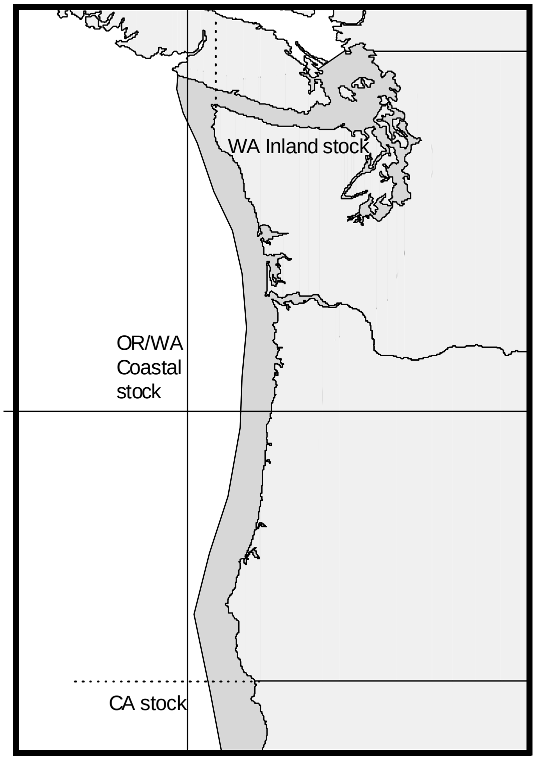

Figure 1. Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

POPULATION SIZE

Aerial surveys of harbor seals in Washington were conducted during the pupping season in 1996, during which time the total number of hauled-out seals (including pups) were counted. In 1996 the mean count of harbor seals occurring in Washington's inland waters was 11,135 (CV=0.0160) animals (Jeffries et al. 1997).

Radio-tagging studies conducted at 6 locations (3 Washington inland waters sites and 3 Oregon and Washington coastal sites) collected information on haulout patterns from 63 harbor seals in 1991 and 61 harbor seals in 1992. Data from coastal and inland sites were not significantly different and were thus pooled, resulting in a correction factor of 1.53 (CV=0.065) to account for animals in the water which are missed during the aerial surveys (Huber 1995). Utilizing this correction factor results in a population estimate of 17,036 (11,135 x 1.53; CV=0.067) for the Inland Washington 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 17,036 and its associated CV(N) of 0.067, N_{MIN} for this stock is 16,104.

Current Population Trend

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

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

From 1983 to 1996, counts of harbor seals in Washington state have increased at an annual rate of 10% (Jeffries et al. 1997). Because the population was not at a very low level, the observed rate of increase will underestimate the maximum net productivity (R_{MAX}). Therefore, until additional data become available, the pinniped 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 Inland Washington stock of harbor seals, PBR = 966 animals (16,104 x 0.06 x 1.0).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

With the exception of 1994, NMFS observers monitored the northern Washington marine set gillnet fishery during 1990-1996 (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 Coast and Inland Washington stocks) occurring in Washington State waters. Some of the animals taken in the inland waters portion of the fishery may have been animals from the coastal stock. Similarly, some of the animals taken in the coastal portion of the fishery (see stock assessment report for the Oregon and Washington Coast stock for details) may have been from the inland stock. For the purposes of this stock assessment report, the animals taken in the inland portion of the fishery are assumed to have belonged to the Inland Washington stock and the animals taken in the coastal portion of the fishery are assumed to have belonged to the Oregon and Washington Coast stock. However, as noted, some movement of animals between Washington's coastal and inland waters is likely, although data from tagging studies have not shown movement of harbor seals between the two locations (Huber 1995). Accordingly, Table 1 includes data only from that portion of the northern Washington marine set gillnet fishery occurring within the range of the Inland Washington stock (those waters east of Cape Flattery). Data from 1990-96 are included in Table 1, although the mean estimated annual mortality is calculated using the most recent 5 years of available data. As noted above, there was no observer program in 1994. Little effort occurred in the inland portion of the fishery in 1995, observer coverage was lower than usual (24%), and no mortalities were observed. Effort increased in the inland portion of the fishery in 1996 without a concurrent increase in observer coverage (leading to only 6% observer coverage in 1996). No mortalities were observed or reported in 1996. The mean estimated mortality for this fishery is 9.2 (CV=0.43) harbor seals per year from this stock.

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

Table 1. Summary of incidental mortality of harbor seals (Inland Washington stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Data from 1992 to 1996 (or the most recent 5 years of available data) are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. 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	90-96	obs data	6-74%	4, 8, 10, 12, n/a, 0, 0	10, 13, 13, 20, n/a, 0, 0	9.2 (CV=.43)
WA Puget Sound Region salmon set/drift gillnet (observer programs listed below covered segments of this fishery):	-	-	-	-	-	-
Puget Sound non-treaty salmon gillnet (all areas and species)	93	obs data	1.3%	2	n/a	see text
Puget Sound non-treaty chum salmon gillnet (areas 10/11 and 12/12B)	94	obs data	11%	1	10	10 (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						34.2 (CV is n/a)
				Reported mortalities		
WA Puget Sound Region salmon set/drift gillnet	90-96	self reports	n/a	13, 43, 22, 16, n/a, n/a, n/a	n/a	see text
unknown Puget Sound fishery	90-96	strand data	n/a	2, 0, 0, 3, 3, 0, 2	n/a	≥1.6
Minimum total annual mortality						≥35.8 (CV is n/a)

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

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

Combining the estimates from the northern Washington marine set gillnet (9.2), Puget Sound non-treaty chum salmon gillnet in areas 10/11 and 12/12B (10), and Puget Sound treaty and non-treaty sockeye salmon gillnet in areas 7 and 7A (15) fisheries results in an estimated minimum annual mortality rate in observed fisheries of 34.2 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, 34.2 is an underestimate of the harbor seal mortality due to the entire fishery. It is not possible to quantify what percentage of the Washington Puget Sound Region salmon set/drift gillnet fishery was actually observed in 1994. However, the areas having the highest salmon catches and in which a majority of the vessels operated in 1994 were covered by the 1994 observer programs (J. Scordino, pers. comm.).

An additional source of information on the number of harbor seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. Fisher self-reports from 1990-96 for the Washington Puget Sound Region salmon set and drift gillnet fishery are shown in Table 1. Unlike the 1994 observer program data, the self-reported fishery data cover the entire fishery (including treaty and non-treaty components) and have thus been included in the table. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are not available for 1994 and 1995, and considered unreliable for 1996 (see Appendix 4 in Hill and DeMaster, in press).

Strandings of harbor seals entangled in fishing gear or with injuries caused by interactions with gear are a final source of fishery-related mortality information. During the period from 1990 to 1996 small numbers of fishery-related strandings of harbor seals have occurred in most years. As the strandings could not be attributed to a particular fishery, they have been included in Table 1 as occurring in an unknown Puget Sound fishery. Fishery-related strandings during 1992-96 result in an estimated annual mortality of 1.6 harbor seals from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

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

Other Mortality

Strandings of harbor seals resulting from collisions with boats, from gunshot injuries, or entangled in line unrelated to fisheries are another source of mortality data. During the 5-year period from 1992 to 1996 human-related harbor seal strandings of animals form this stock occurred in each year, with 1, 7, 7, 1, and 8 stranding reports in 1992 through 1996, respectively. These mortalities result in an estimated annual mortality of 4.8 (rounded to 5) harbor seals from this stock during 1992-96. This estimate is considered a minimum because not all stranded animals are found, reported, or cause of death determined (via necropsy by trained personnel).

Subsistence Harvests by Northwest Treaty Indian Tribes

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

STATUS OF STOCK

Harbor seals are not considered to be "depleted" under the MMPA or listed as "threatened " or "endangered" under the Endangered Species Act. Based on currently available data, the level of human-caused mortality and serious injury (36+5=41) does not exceed the PBR (966). Therefore, the Inland Washington stock of harbor seal is not classified as a strategic stock. At present, the minimum estimated fishery mortality and serious injury for this stock (36) is less that 10% of the calculated PBR and, therefore, 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.

REFERENCES

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

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

Boveng, P. 1988. Status of the Pacific harbor seal population on the U.S. west coast. Southwest Fisheries Center, NMFS. Admin. Rept. LJ-88-06. 43 pp.

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

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

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

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

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

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

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

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

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

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

Hill, P. S, and D. P. DeMaster. (In press). Alaska marine mammal stock assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC.

Huber, H. 1995. The abundance of harbor seals (*Phoca vitulina richardsi*) in Washington, 1991-1993. MS Thesis, Univ. of Washington, Seattle, Washington. 56 pp.

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

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

Jeffries, S. J., R. F. Brown, H. R. Huber, and R. L. DeLong. 1997. Assessment of harbor seals in Washington and Oregon 1996. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. Available at National Marine Mammal

Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

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

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

Northwest Indian Fisheries Commission. 1995. Monitoring of marbled murrelet and marine mammal interactions with 1994 tribal gillnet fisheries in northern Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Final Report to NMFS contract no. 52ABNF400087. Unpubl. report. Northwest Indian Fisheries Commission. 43 pp. Available at NWIFC, 6730 Martin Way E, Olympia, WA, 98516.

Pierce, D. J., M. Alexandersdottir, S. J. Jeffries, P. Erstad, W. Beattie, and A. Chapman. 1996. Interactions of marbled murrelets and marine mammals with the 1994 Puget sound sockeye gill net fishery. Final report, Wash. Dept. Fish and Wildlife, Olympia, WA. 21 pp.

Pierce, D. J., W. P. Ritchie, and R. Kreuziger. 1994. Preliminary findings of seabird interactions with the non-treaty salmon gill net fishery: Puget Sound and Hood Canal Washington. Unpubl. report. Washington Department of Fish and Wildlife, Olympia, WA. 39 pp. Available at WDFW, 600 Capitol Way N, Olympia, WA, 98501.

Pitcher, K. W., and D. G. Calkins. 1979. Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 19(1983):231-310.

Pitcher, K. W., and D. C. McAllister. 1981. Movements and haul out behavior of radio-tagged harbor seals, *Phoca vitulina*. Can. Field Nat. 95:292-297.

Scheffer, V. B., and J. W. Slipp. 1944. The harbor seal in Washington state. Amer. Midl. Nat. 32:373-416.

Scordino, J. National Marine Fisheries Service, Northwest Region, 7600 Sand Point Way NE, Seattle, WA, 98115.

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

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

Revised 12/15/98

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

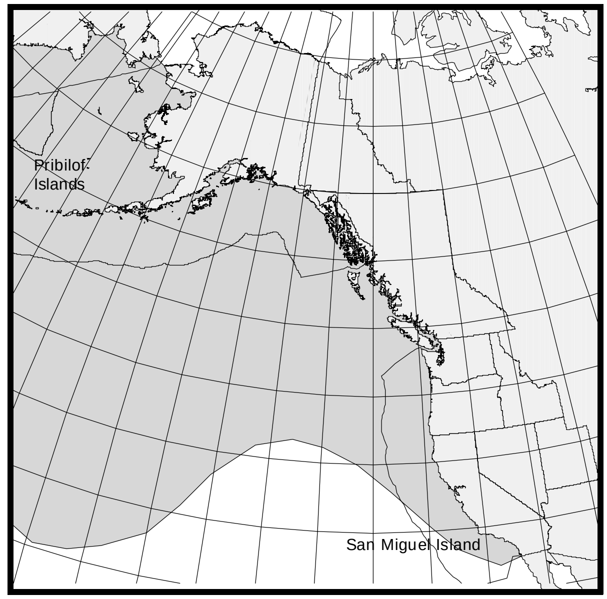

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

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

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

POPULATION SIZE

The population estimate for the San Miguel Island stock of northern fur seals is calculated as the estimated number of pups at rookeries multiplied by an expansion factor. Based on research conducted on the Eastern Pacific stock of northern fur seals, a life table analysis was performed to estimate the number of yearlings, 2 year olds, 3 year olds, and animals at least 4 years old (Lander 1981). The resulting population estimate was equal to the pup count multiplied by 4.475. The expansion factors are based on a sex and age distribution estimated after the harvest of juvenile males was terminated. A more appropriate expansion factor for the San Miguel Island stock is 4.0, based on the known increased immigration of recruitment-age females (DeLong 1982) and mortality and possible emigration of adults associated with the El Niño Southern Oscillation event in 1982-1983 (DeLong, pers. comm.). The most recent pup count occurred in 1997, resulting in a total count of 3,176 (NMFS, unpubl. data). Based on the 1997 count and the expansion factor, the most recent population estimate of the San Miguel Island stock is 12,704 (3,176x4.0) northern fur seals. Currently, a CV for the expansion factor is unavailable.

Minimum Population Estimate

The survey technique utilized for estimating the abundance of northern fur seals within the San Miguel Island stock is a direct count, with no associated CV(N) as sites are surveyed only once. Additional estimates of the overall population size (i.e., N_{BEST}) and associated CV are also unavailable. Therefore N_{MIN} for this stock can not be estimated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Rather, N_{MIN} is estimated as twice the maximum number of pups born in 1997 (to account for the pups and their mothers) plus the maximum number of adult and sub-adult males counted for the 1997 season which results in an N_{MIN} of 6,720 ((3,176x2)+368). This method provides a very conservative estimate of the northern fur seal population at San Miguel Island.

Current Population Trend

The population of northern fur seals on San Miguel Island 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 and have increased thereafter (Fig. 2).

The 1997 live pup count of 2,706 was the highest reported at the San Miguel colony since it was discovered in 1968 (S. Melin, unpubl. data). Up to 75% of pups born in 1997 died within 5 months of birth, and pups surviving to weaning were very emaciated. It is expected there will be no survival of pups from the 1997 cohort (DeLong et al. 1998 at http://nmml.afsc.noaa.gov/el_nino). However, because the San Miguel Island stock is small and located at the southern extent of the species' range, it appears to be more sensitive to environmental fluctuations than the Pribilof Island population and thus experiences greater fluctuations in population trends. The San Miguel Island stock will likely experience increased emigration and pup and adult mortality in 1998 if the predicted El Niño Southern Oscillation event is as strong as the 1982-83 event, which may result in slowed population growth or decline in the next few years.

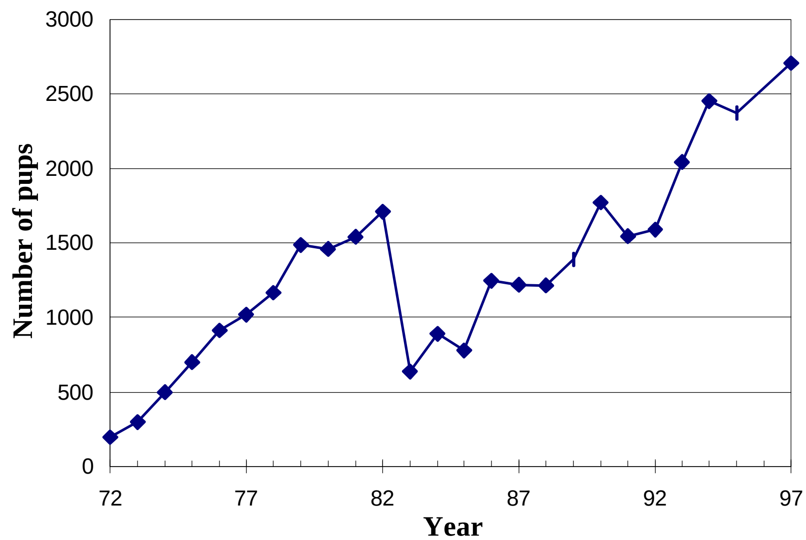

Figure 2. Northern fur seal live pup counts on San Miguel Island, 1972-97. Counts from 1996 were incomplete and have not been included the figure.

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 = 270 animals (6,720 x 0.043 x 1.0).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Northern fur seals taken during the winter/spring along the west coast of the continental U. S. could be from the Pribilofs and thus belong to the Eastern Pacific stock. However, it is the intention of NMFS to consider any takes of northern fur seals by commercial fisheries in waters off California, Oregon and Washington as being from the San Miguel Island stock. Information concerning the three observed fisheries that may have interacted with northern fur seals are listed in Table 1. There were no reported mortalities of northern fur seals in any observed fishery along the west coast of the continental U. S. during the period from 1990-96. Fishing effort in the California angel shark/halibut set gillnet fishery was substantially reduced as a result of a California voter proposition banning gillnet fishing in certain areas (Julian 1997, Julian and Beeson 1998). For this fishery, there were no observed sets after 1994. The estimated mean mortality rate in observed fisheries is zero northern fur seals per year from this stock.

An additional source of information on the number of northern fur seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1996, fisher self-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 of northern fur seals. Mortality of northern fur seals incidental to these fisheries, if it occurred, indeed appears minimal. Self-reported fisheries data are not available for 1994 and 1995, and considered unreliable for 1996 (see Appendix 4 of Hill and DeMaster 1998).

Table 1. Summary of incidental mortality of northern fur seals (San Miguel Island stock) due to commercial fisheries from 1990 through 1996 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	Reported mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
CA/OR thresher shark and swordfish drift gillnet	90-96	obs data	4-18%	0, 0, 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)	90-96	obs data	44-72%	0, 0, 0, 0, 0, 0, 0	0, 0, 0, 0, 0, 0, 0	0
Observer program total						0
CA/OR thresher shark and swordfish drift gillnet	90-96	self reports	n/a	1, 0, 0, 0, n/a, n/a, n/a	n/a	-
CA angel shark/halibut set gillnet	90-96	self reports	n/a	1, 0, 1, 0, n/a, n/a, n/a	n/a	-
unknown west coast fishery	90-96	strand data	n/a	2, 0, 0, 0, 0, 0, 0	n/a	0
Minimum total annual mortality					Total	0

Strandings of northern fur seals entangled in fishing gear or with injuries caused by interactions with gear are a final source of fishery-related mortality information. During 1990-96 the only reported northern fur seal strandings occurred in 1990 (Table 1). The strandings could not be attributed to a particular fishery and as a result have been included as unknown west coast fishery. Fishery-related strandings during 1992-96 result in an estimated annual mortality of zero animals from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

STATUS OF STOCK

The San Miguel Island northern fur seal stock is not considered to be "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the estimated annual level of total human-caused mortality and serious injury (0) does not exceed the PBR (270). Therefore, the San Miguel Island stock of northern fur seal is not classified as a strategic stock. The minimum total fishery mortality and serious injury for this stock (0) is not known to exceed 10% of the calculated PBR 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.

REFERENCES

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

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

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

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

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

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

Hill, P. S, and D. P. DeMaster. 1998. Alaska marine mammal stock assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-xxx. In press.

Julian, F. 1997. Cetacean mortality in California gillnet fisheries: preliminary estimates for 1996. Unpubl. doc. submitted to Int. Whal. Commn. (SC/49/SM). 13 pp.

Julian, F., and M. Beeson. 1998. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

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

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

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

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

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

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

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

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

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-round in the inland trans-boundary area of Washington and British Columbia, Canada (Osborne et al. 1988) and along the Oregon/Washington coast (Barlow 1988, Barlow et al. 1988, Green et al. 1992). Aerial survey data from coastal Oregon and Washington, collected during all seasons, suggests that harbor porpoise distribution varies by depth (Green et al. 1992). Although distinct seasonal changes in abundance along the west coast have been noted and attributed to possible shifts in distribution to deeper offshore waters during late winter (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.

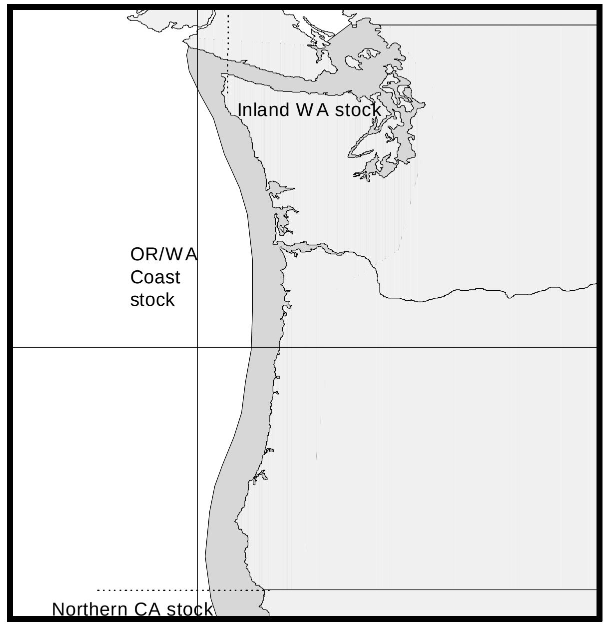

Figure 1. Approximate distribution of harbor porpoise in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the stocks are shown.

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 specimens from the North Atlantic, where numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles.

Using the 1990-91 aerial survey data of Calambokidis et al. (1993b) for water depths < 50 fathoms, Osmek et al. (1996) found significant differences in harbor porpoise mean densities ($z=5.9$, $p<0.01$) between the waters of coastal Oregon/Washington and inland Washington/southern British Columbia, Canada (i.e., Strait of Juan de Fuca/San Juan Islands). Although differences in density exist between coastal Oregon/Washington and inland Washington, a specific stock boundary line cannot be identified based upon biological or genetic differences. However, because harbor porpoise movements and rates of intermixing within the northeast Pacific are restricted, there has been a significant decline in harbor porpoise sightings within southern Puget Sound since the 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 two stocks be recognized in California, with the stock boundary at the Russian River. 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. 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 and are considered separately in the Stock Assessment Reports for the Alaska Region. The harbor porpoise occurring in British Columbia have not been included in any stock assessment report from either the Alaska or Pacific (Oregon/Washington) Regions.

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.

An aerial survey for harbor porpoise covering the coasts of Oregon, Washington, and southern British Columbia was conducted during August and September of 1997. Results from this survey will be incorporated into the 1999 revision of this stock assessment.

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(N) 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 0.5, the value for a cetacean stock with an unknown population status (Wade and Angliss 1997). Thus, for Oregon/Washington Coast stock of harbor porpoise, PBR = 220 animals (22,046 x 0.02 x 0.5).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Within the EEZ boundaries of coastal Oregon and Washington, human-caused (fishery) mortalities of harbor 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 monitored the northern Washington marine set gillnet fishery during 1990-1996 (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). No fishing effort occurred in the coastal portion of the fishery in 1993 and, as noted above, no observer program occurred in 1994. Data from 1990 to 1996 are included in the Table 1, although the mean estimated annual mortality is calculated using the most recent 5 years of available data. The mean estimated mortality for this fishery is 16.6 (CV=0.28) harbor porpoises per year from this stock.

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

Table 1. Summary of incidental mortality of harbor porpoises (Oregon and Washington Coast stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Data from 1992 to 1996 (or the most recent 5 years of available data) are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. 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	90-96	obs data	68-100%	13, 13, 0, n/a, n/a, 20, 29	16, 18, 0, n/a, n/a, 20, 29	16.6 (CV= 0.28)
Observer program total						16.6
Estimated total annual mortality						16.6 (CV=0.28)

An additional source of information on the number of harbor porpoises killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1996, there were no fisher self-reports of harbor porpoise mortalities from any fisheries operating within the range of the Oregon/Washington Coast stock. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are not available for 1994 and 1995, and considered unreliable for 1996 (see Appendix 4 in Hill and DeMaster, in press).

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

STATUS OF STOCK

Harbor porpoise are not considered 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 (17) does not exceed the PBR (220). Therefore, the Oregon/Washington Coast stock of harbor porpoise is not classified as strategic. The total fishery mortality and serious injury for this stock (17; based on observer data) is not known to exceed 10% of the calculated PBR 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.

REFERENCES

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

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

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

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

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

Calambokidis, J., J. C. Cubbage, S. J. Jeffries, P. J. Gearin and R. F. Brown. 1991. Harbor porpoise distribution and abundance estimates of Washington from aerial surveys in 1991. Final Rep. by Cascadia Research, Olympia, WA to National Marine Mammal Laboratory, AFSC, NMFS, Seattle, WA. 35 pp.

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

Calambokidis, J., J. R. Evenson, J. C. Cubbage, S. D. Osmek, D. J. Rugh, and J. L. Laake. 1993a. Calibration of sighting rates of harbor porpoise from aerial surveys. Final Rep. by Cascadia Research, Olympia, WA to National Marine Mammal Laboratory, AFSC, NMFS, Seattle, WA. 41 pp.

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

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

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

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

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

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

Gearin, P. J., M. E. Gosho, L. Cooke, R. DeLong, and J. Laake. 1996. Acoustic alarm experiment in the 1995 northern Washington marine setnet fishery: methods to reduce by-catch of harbor porpoise. Int. Whal. Commn. Working Paper SC/48/SM10. 15 pp.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnel, and K. C. Balcomb. 1992. Cetacean distribution and abundance of Oregon and Washington, 1989-1990. Ch. 1 *In* Brueggeman, J. J. (ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. OCS Study MMS 91-0093.

Hill, P. S, and D. P. DeMaster. (In press). Alaska marine mammal stock assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC.

Kraus, S. D., A. J. Read, A. Solow, K. Baldwin,, T. Spradlin, E. Anderson, and J. Williamson. 1997. Acoustic alarms reduce porpoise mortality. Nature 388:525.

Laake, J. L., P. J. Gearin, M. E. Gosho, and R. L. DeLong. 1997. Evaluation of the effectiveness of pingers to reduce incidental entanglement of harbor porpoise in a set gillnet fishery. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 7 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Laake, J. L., D. J. Rugh, and L. S. Baraff. 1998. Observations of harbor porpoise in the vicinity of acoustic alarms on a set gillnet. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-84, 40 pp.

Osborne, R., J. Calambokidis and E. M. Dorsey. 1988. A guide to marine mammals of greater Puget Sound. Island Publishers, Anacortes, WA. 191 pp.

Osmek, S. J., P. E. Rosel, A. E. Dizon, and R. L. DeLong. 1994. Harbor porpoise, *Phocoena phocoena*, population assessment studies for Oregon and Washington in 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 14 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Osmek, S., J. Calambokidis, J. Laake, P. Gearin, R. DeLong, J. Scordino, S. Jeffries and R. Brown. 1996. Assessment of the status of harbor porpoises, *Phocoena phocoena*, in Oregon and Washington waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-76, 46 pp.

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

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

Taylor, B. Southwest Fisheries Science Center, P. O. Box 271, La Jolla, California, 92038.

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

Revised 12/15/98

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-round in the inland trans-boundary area of Washington and British Columbia, Canada (Osborne et al. 1988) and along the Oregon/Washington coast (Barlow 1988, Barlow et al. 1988, Green et al. 1992). Aerial survey data from coastal Oregon and Washington, collected during all seasons, suggests that harbor porpoise distribution varies by depth (Green et al. 1992). Although distinct seasonal changes in abundance along the west coast have been noted and attributed to possible shifts in distribution to deeper offshore waters during late winter (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.

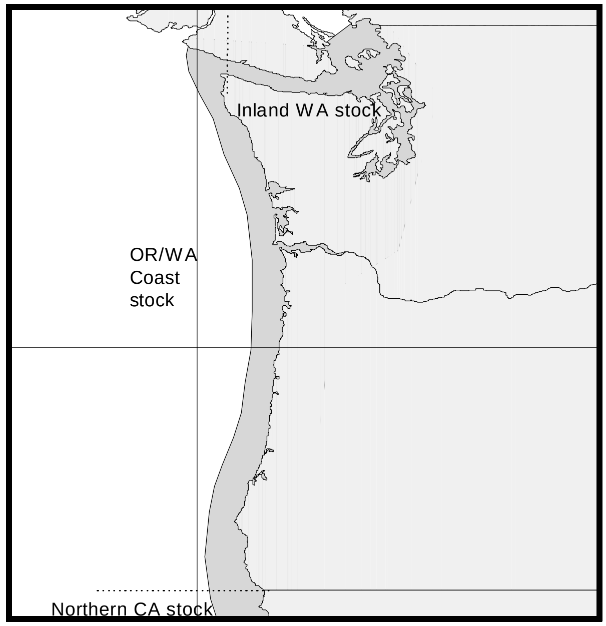

Figure 1. Approximate distribution of harbor porpoise in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the stocks are shown.

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.

Using the 1990-91 aerial survey data of Calambokidis et al. (1993) for water depths < 50 fathoms, Osmek et al. (1996) found significant differences in harbor porpoise mean densities ($z=5.9$, $p<0.01$) between the waters of coastal Oregon/Washington and inland Washington/southern British Columbia, Canada (i.e., Strait of Juan de Fuca/San Juan Islands). Although differences in density exist between coastal Oregon/Washington and inland Washington, a specific stock boundary line cannot be identified based upon biological or genetic differences. However, because harbor porpoise movements and rates of intermixing within the northeast Pacific are restricted, there has been a significant decline in harbor porpoise sightings within southern Puget Sound since the 1940s, and following a risk averse management strategy, two stocks are recognized to occur in Oregon and Washington waters (the Oregon/Washington Coast stock and the Inland Washington stock), with the boundary at Cape Flattery. 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 two stocks be recognized in California, with the stock boundary at the Russian River. 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 Inland Washington stock. 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 and are considered separately in the Stock Assessment Reports for the Alaska Region. The harbor porpoise occurring in British Columbia have not been included in any stock assessment report from either the Alaska or Pacific (Oregon/Washington) Regions.

POPULATION SIZE

Aerial surveys of the inside waters of Washington and southern British Columbia were conducted during August of 1996 (Calambokidis et al. 1997). These aerial surveys included the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, and Strait of Georgia, which includes waters inhabited by harbor porpoise from British Columbia, as well as the Inland Washington stock. A total of 2,725 km of survey effort was completed within U. S. waters, resulting in an uncorrected abundance of 1,025 harbor porpoise in the inside waters of Washington (Calambokidis et al. 1997, Laake et al. 1997a). When corrected for availability and perception bias (g(0)=0.292, SE=0.107), the estimated abundance for the Inland Washington stock of harbor porpoise is 3,509 (CV=0.396) animals (Laake et al. 1997a, 1997b).

Minimum Population Estimate

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

Current Population Trend

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

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is not currently available for harbor 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.4, the value for a cetacean stock with an unknown population status and with a CV of mortality estimates greater than 0.8 (Wade and Angliss 1997). Thus, for the Inland Washington stock of harbor porpoise, PBR = 20 animals (2,545 x 0.02 x 0.4).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

With the exception of 1994, NMFS observers monitored the northern Washington marine set gillnet fishery during 1990-1996 (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 1990-96 are included in Table 1, although the mean estimated annual mortality is calculated using the most recent 5 years of available data. As noted above, there was no observer program in 1994. 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. Effort increased in the inland portion of the fishery in 1996 without a concurrent increase in observer coverage (leading to only 6% observer coverage in 1996). No mortalities were either observed or reported in 1996. The mean estimated mortality for this fishery is 0.4 (CV=1.0) harbor porpoise per year from this stock.

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

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

Also in 1994, NMFS in conjunction with the 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 (0.4) results in an estimated mean mortality rate in observed fisheries of 15.4 harbor porpoise per year from this stock. It should be noted that the 1994 observer programs did not sample all segments of the entire Washington Puget Sound Region salmon set/drift gillnet fishery, and further, the extrapolation of total kill did not include effort for the unobserved segments of this fishery. Therefore, 15 is an underestimate of the harbor porpoise mortality due to the entire fishery. Though it is not possible to quantify what percentage of the Washington Puget Sound Region salmon set/drift gillnet fishery was actually observed in 1994, the observer programs covered those segments of the fishery which had the highest salmon catches, the majority of vessel participation, and the highest likelihood of interaction with harbor porpoise (J. Scordino, pers. comm.). Accordingly, the estimated harbor porpoise mortality (15) appears to be only a slight underestimate for the fishery. See Appendix 1 of Barlow et al. (1997) for additional information, including a map depicting fishing areas, regarding the Washington Puget Sound Region salmon set/drift gillnet fishery.

An additional source of information on the number of harbor porpoises killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. Self-reported fishery data from 1990-96 for the Washington Puget Sound Region salmon set and drift gillnet fishery are shown in Table 1. Unlike the 1994 observer program data, the self-reported fisheries data cover the entire fishery. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates of harbor porpoise mortality. Self-reported fisheries data are not available for 1994 and 1995, and considered unreliable for 1996 (see Appendix 4 in Hill and DeMaster, in press). Though the 1994 observer program data may underestimate the total fishery mortality for this stock, it is considered more reliable than the self-reported data. Thus, the self-reported fisheries data were not used in the mortality rate calculation.

Table 1. Summary of incidental mortality of harbor porpoise (Inland Washington stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Data from 1992 to 1996 (or the most recent 5 years of available data) are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. 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	90-96	obs data	24-74%	0, 1, 0, 0, n/a, 0, 0	0, 2, 0, 0, n/a, 0, 0	0.4 (CV=1.0)
WA Puget Sound Region salmon set/drift gillnet (observer programs listed below covered segments of this fishery):	-	-	-	-	-	-
Puget Sound non-treaty salmon gillnet (all areas and species)	93	obs data	1.3%	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						15.4 (CV=.97)
				Reported mortalities		
WA Puget Sound Region salmon set/drift gillnet	90-96	self reports	n/a	6, 4, 6, 2, n/a, n/a, n/a	n/a	see text
Minimum total annual mortality						≥15.4 (CV=.97)

Strandings of harbor porpoise wrapped in fishing gear or with injuries caused by interactions with gear are a final source of fishery-related mortality information. During the period from 1990 to 1996 the only reported fishery-related strandings of harbor porpoise occurred in 1992 (1 animal) and 1993 (1 animal). The mortalities likely occurred in the Washington Puget Sound Region salmon set and drift gillnet fishery. As the 1994 observer program already accounts for 15 harbor porpoise mortalities per year from this fishery, these strandings are not included in Table 1.

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

STATUS OF STOCK

Harbor porpoise are not listed as "depleted" under the MMPA or listed as "threatened " or "endangered" under the Endangered Species Act. Based on currently available data, the level of human-caused mortality and serious injury (16) is not known to exceed the PBR (20). Therefore, the Inland Washington harbor porpoise stock is not classified as strategic. The minimum total fishery mortality and serious injury for this stock (rounded up to 16) exceeds 10% of the calculated PBR 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 since the 1940s.

Although this stock is not recognized as strategic at this time there is cause for concern due to the following issues: 1) the estimated take level is close to exceeding the PBR (i.e., one additional observed mortality or serious injury in the area 7/7A sockeye drift gillnet fishery would increase the estimated annual take level above the PBR), 2) the extent to which harbor porpoise from U. S. waters frequent the waters of British Columbia, and are therefore subject to fishery-related mortality, is unknown, and 3) the mortality rate is based on observer data from a subset of the Washington Puget Sound Region salmon set and gillnet fishery.

REFERENCES

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

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

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

Barlow , J., R. W. Baird, J. E. Heyning, K. Wynne, A. M. Manville, II, L. F. Lowry, D. Hanan, J. Sease, and V. N. Burkanov. 1994. A review of cetacean and pinniped mortality in coastal fisheries along the west coast of the USA and Canada and the east coast of the Russian Federation. Rep. Int. Whal. Commn. (Special Issue) 15:405-425.

Barlow, J., K. A. Forney, P. S. Hill, R. L. Brownell Jr., J. V. Carretta, D. P. DeMaster, F. Julian, M. S. Lowry, T. Ragen, and R. R. Reeves. 1997. U. S. Pacific marine mammal stock assessments, 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-248, 223 pp.

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

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

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

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

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

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

Everitt, R. D., C. H. Fiscus, R. L. DeLong. 1980. Northern Puget Sound marine mammals. U.S. Department of Commerce EPA-6000/7-80-139. 134 pp.

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

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

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

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnel, and K. C. Balcomb. 1992. Cetacean distribution and abundance of Oregon and Washington, 1989-1990. Ch. 1 *In* Brueggeman, J. J. (Ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. OCS Study MMS 91-0093.

Hill, P. S, and D. P. DeMaster. (In press). Alaska marine mammal stock assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC.

Laake, J. L., R. L. DeLong, J. Calambokidis, and S. D. Osmek. 1997a. Abundance and distribution of marine mammals in Washington and British Columbia inside waters, 1996. Annual rep. to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 7 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Laake, J. L., J. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997b. Probability of detecting harbor porpoise from aerial surveys: Estimating g(0). J. Wildl. Manage. 61(1):63-75.

Northwest Indian Fisheries Commission. 1995. Monitoring of marbled murrelet and marine mammal interactions with 1994 tribal gillnet fisheries in northern Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Final Report to NMFS contract no. 52ABNF400087. Unpubl. report. Northwest Indian Fisheries Commission. 43 pp. Available at NWIFC, 6730 Martin Way E, Olympia, WA, 98516.

Osborne, R., J. Calambokidis and E. M. Dorsey. 1988. A guide to marine mammals of greater Puget Sound. Island Publishers, Anacortes, WA. 191 pp.

Osmek, S. D., P. E. Rosel, A. E. Dizon, and R. L. DeLong. 1994. Harbor porpoise *Phocoena phocoena* population assessment studies for Oregon and Washington in 1993. Annual rep. to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 14 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Osmek, S. D., M. B. Hanson, J. L. Laake, S. J. Jeffries, and R. L. DeLong. 1995. Harbor porpoise *Phocoena phocoena* population assessment studies for Oregon and Washington in 1994. Annual rep. to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 32 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Osmek, S., J. Calambokidis, J. Laake, P. Gearin, R. DeLong, J. Scordino, S. Jeffries and R. Brown. 1996. Assessment of the status of harbor porpoises, *Phocoena phocoena*, in Oregon and Washington waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-76, 46 pp.

Pierce, D. J., M. Alexandersdottir, S. J. Jeffries, P. Erstad, W. Beattie, and A. Chapman. 1996. Interactions of marbled murrelets and marine mammals with the 1994 Puget sound sockeye gill net fishery. Final report, Wash. Dept. Fish and Wildlife, Olympia, WA. 21 pp.

Pierce, D. J., W. P. Ritchie, and R. Kreuziger. 1994. Preliminary findings of seabird interactions with the non-treaty salmon gill net fishery: Puget Sound and Hood Canal Washington. Unpubl. report. Washington Department of Fish and Wildlife, Olympia, WA. 39 pp. Available at WDFW, 600 Capitol Way N, Olympia, WA, 98501.

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

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

Scheffer, V. B. and J. W. Slipp. 1948. The whales and dolphins of Washington state with a key to the cetaceans of the west coast of North America. Am. Midl. Nat. 39(2), 257-337.

Scordino, J. National Marine Fisheries Service, Northwest Region, 7600 Sand Point Way NE, Seattle, Washington, 98115.

Stacey, P. J., R. W. Baird, and D. A. Duffus. 1997. A preliminary evaluation of incidental mortality of small cetaceans, in coastal fisheries in British Columbia, Canada. Mar. Mamm. Sci. 13:321-326.

Taylor, B. Southwest Fisheries Science Center, P. O. Box 271, La Jolla, California, 92038.

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

MESOPLODONT BEAKED WHALES (*Mesoplodon* spp.): California/Oregon/Washington Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

Mesoplodont beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific Ocean. At least 5 species in this genus have been recorded off the U.S. west coast, but due to the rarity of records and the difficulty in identifying these animals in the field, virtually no species-specific information is available (Mead 1989). The five species known to occur in this region are: Blainville's beaked whale (*M. densirostris*), Hector's beaked whale, (*M. hectori*), Stejneger's beaked whale (*M. stejnegeri*), Gingko-toothed beaked whale (*M. gingkodens*), and Hubbs' beaked whale (*M. carlhubbsi*). Insufficient sighting records exist off the U.S. west coast (Figure 1) to determine any possible spatial or seasonal patterns in the distribution of mesoplodont beaked whales.

Until methods of distinguishing these five species are developed, the management unit must be defined to include all *Mesoplodon* stocks in this region. However, in the future, species-level management is desirable, and a high priority should be placed on finding means to obtain species-specific abundance information. For the Marine Mammal Protection Act (MMPA) stock assessment reports, three *Mesoplodon* stocks are defined: 1) all *Mesoplodon* species off California, Oregon and Washington (this report), 2) *M. stejnegeri* in Alaskan waters, and 3) *M. densirostris* in Hawaiian waters.

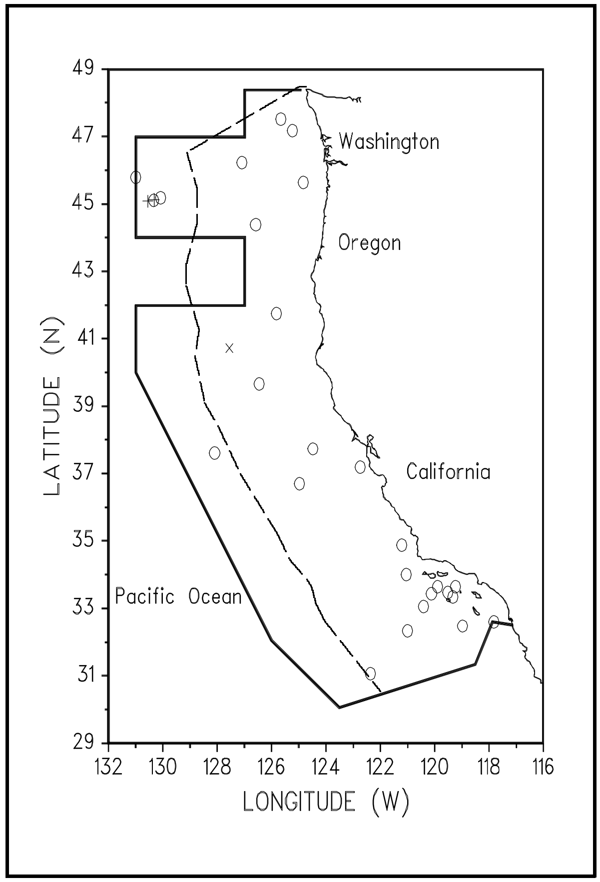

Figure 1. *Mesoplodon* beaked whale sightings based on aerial and shipboard surveys off California, Oregon and Washington, 1975-1994. Key: **F** = *Mesoplodon* sp.; + = *Mesoplodon carlhubbsi*; × = *Mesoplodon densirostris* (see Appendix 2 in Barlow et al. 1997 Appendix 2 for data sources and information 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 include animals off Oregon/Washington. Furthermore, there were a large number of unidentified beaked whale sightings, which were either *Mesoplodon* sp. or Cuvier's beaked whales (*Ziphius cavirostris*). Recent analyses (Barlow and Gerrodette 1996, Barlow and Sexton 1996, Barlow 1997) have resulted in improved estimates of abundance by 1) combining data from three surveys conducted in 1991, 1993, and 1996 within 300 nmi of the California coast, 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, 3) estimating a correction factor for animals missed because they are submerged, based on dive-interval data collected for mesoplodont whales in 1993-95 (about 26% of all trackline groups are estimated to be seen) and 4) conducting surveys off Oregon and Washington in summer/fall 1996. Furthermore, the first species-specific abundance estimate is now available for Blainville’s beaked whale, which was identified once during the 1993 cruise. Combining the average 1991-96 abundance estimates in Barlow (1997) with the correction factor estimated by Barlow and Sexton (1996), the new estimates of abundance are 3,738 (CV = 0.46) mesoplodont beaked whales of unknown species plus 360 (CV = 2.0) Blainville's beaked whales.

Minimum Population Estimate

Based on the combined abundance estimate of 4,098 (CV = 0.46) , the minimum population estimate (defined as the log-normal 20th percentile of the abundance estimate) for mesoplodont beaked whales in California, Oregon, and Washington is 2,840 animals. This includes a species-specific minimum abundance estimate of 123 Blainville's beaked whales.

Current Population Trend

Due to the rarity of sightings of these species on surveys along the U.S. West coast, no information exists regarding possible trends in abundance.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for mesoplodont beaked whales.

POTENTIAL BIOLOGICAL REMOVAL

Based on the unknown status and growth rate of mesoplodont beaked whales, and given the precision of the estimate of annual fishery mortality (CV≈0.65), the recovery factor (F_r) is 0.45. ½R_{max} is the default value of 0.02. Multiplying these two values times the minimum population estimate of 2,840 yields a potential biological removal (PBR) of 26 mesoplodont beaked whales per year, including at least 1.1 Blainville's beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for mesoplodont beaked whales in this region is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1 of Barlow et al. (1997). 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 average estimated annual mortality for all mesoplodont beaked whales in this fishery for the five most recent years of monitoring, 1992-96 , is 9.2 (CV=0.65) if only animals identified to the genus *Mesoplodon* are included, or 13 (CV=0.66) if the "unidentified beaked whales" are considered to have been mesoplodont beaked whales (Table 1).

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 considered "depleted" under the MMPA. The estimated annual human-caused mortality in 1992-96 for all mesoplodont beaked whales combined (9.2) plus all unidentified beaked whales (4.2) is less than the PBR (26); therefore, this group of species is not classified as a "strategic" stock as defined by the MMPA. The total fishery mortality and serious injury for all mesoplodont beaked whales exceeds 10% of the PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. 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 (Julian 1997; Julian and Beeson, in press). All observed entanglements of *Mesoplodon* beaked whales resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes 1992-96
CA/OR thresher shark/swordfish drift gillnet fishery	Hubbs' beaked whale, *Mesoplodon carlhubbsi*					
	observer data	1992 1993 1994 1995 1996	13.6% 13.4% 17.9% 15.6% 12.4%	3 0 2 0 0	22 (0.53) 0 11 (0.64) 0 0	6.6 (0.67)
	Stejneger's beaked whale, *Mesoplodon stejnegeri*					
	observer data	1992 1993 1994 1995 1996	13.6% 13.4% 17.9% 15.6% 12.4%	0 0 1 0 0	0 0 6 (0.91) 0 0	1.2 (1.00)
	Unidentified *Mesoplodon* beaked whale					
	observer data	1992 1993 1994 1995 1996	13.6% 13.4% 17.9% 15.6% 12.4%	1 0 0 0 0	7 (0.93) 0 0 0 0	1.4 (1.00)
	Unidentified beaked whale (probably *Mesoplodon*)					
	observer data	1992 1993 1994 1995 1996	13.6% 13.4% 17.9% 15.6% 12.4%	2 0 1 0 0	15 (0.65) 0 6 (0.90) 0 0	4.2 (0.70)
Minimum total annual takes of *Mesoplodon* beaked whales 1992-96						9.2 (0.65) to 13 (0.66)

REFERENCES

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon, and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Southwest Fisheries Science Center Administrative Report. LJ-97-11. 25pp.

Barlow, J., K. A. Forney, P. S. Hill, R. L. Brownell, Jr., J. V. Carretta, D. P. DeMaster, F. Julian, M. S. Lowry, T. Ragen, and R. R. Reeves. 1997. U.S. Pacific Marine Mammal Stock Assessments: 1996. NOAA Technical Memorandum NOAA-TM-NMFS-SWFC-248. 223pp.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-233.

Barlow, J. and S. Sexton. 1996. The effect of diving and searching behavior on the probability of detecting track-line groups, g_0, of long-diving whales during line transect surveys. Administrative Report LJ-96-14. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038, USA. 21 p.

Henshaw, M. D., R. G. LeDuc, S. J. Chivers, and A. E. Dizon. 1997. Identifying beaked whales (family Ziphiidae) using mtDNA sequences. Marine Mammal Science 13:487-495.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: preliminary estimates for 1996. Int. Whal. Commn. Working Paper SC/49/SM2. 13pp.

Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fishery Bulletin 96:271-284.

Mead, J. G. 1989. Beaked whales of the genus *Mesoplodon*. *In*: Ridgway, S. H. and Harrison, R. (eds.), Handbook of Marine Mammals, Vol. 4., p. 349-430. Academic Press Limited.

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

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thompson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 p.

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

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 for the Alaska Region.

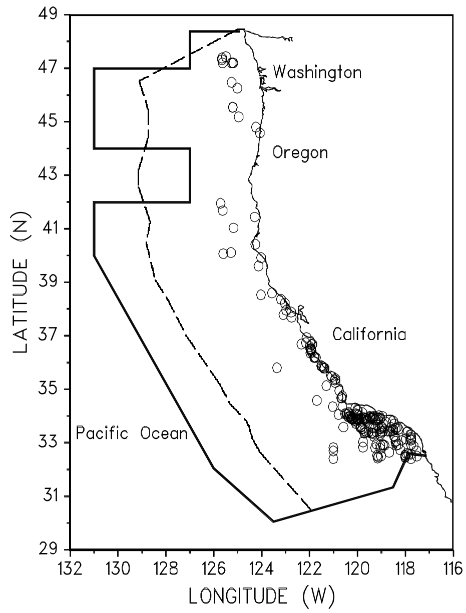

Figure 8. Minke whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1975-94 (see Barlow et al. 1997, Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

POPULATION SIZE

No estimates have been made for the number of minke whales in the entire North Pacific. The number of minke whales is estimated as 631 (CV = 0.45) based on ship surveys in 1991, 1993, and 1996 off California and in 1996 off Oregon and Washington (Barlow 1997.). Forney et al. (1995) estimate at total of 73 (CV=0.62) in California based on an aerial survey, but this estimate is negatively biased because it excludes diving whales. In addition, Green et al. (1992) report 4 sightings of minke whales in aerial surveys of Oregon and Washington, but they did not estimate population size for that area.

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 surveys in California, Oregon, and Washington waters (Barlow 1997) or approximately 440. More sophisticated methods of estimating minimum population size would be available if a correction factor (and associated variance) were available to correct the aerial survey estimates for missed animals.

Current Population Trend

There are no data on trends in minke whale abundance in waters of California, Oregon and/or Washington.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of minke whale populations in the North Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (440) times one half the default maximum net growth rate for cetaceans (1/2 of 4%) times a recovery factor of 0.45 (for a stock of unknown status and a mortality CV = 0.67), resulting in a PBR of 4.0.

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.).

Fishery Information

Minke whales may occasionally be caught in coastal set gillnets off California, in salmon drift gillnets in Puget Sound, Washington, and in offshore drift gillnets off California and Oregon. A summary of known fishery mortality and injury for this stock of minke whales is given in Table 1. Detailed information on this fishery is provided in Barlow et al. (1997, Appendix 1). The average fishery mortality is estimated to be 3.6 (CV=0.67) minke whales per year for the five most recent years of monitoring (1992-96). Total fishery mortality for minke whales was not estimated for the 1980-86 California Department of Fish and Game set and drift gillnet 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.

Table 1. Summary of available information on the incidental mortality and injury of minke whales (CA/OR/WA stock) for commercial fisheries that might take this species (Pierce et al. 1996; Julian 1997, Julian and Beeson, in press).

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes 1992-96 (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1992 1993 1994 1995 1996	observer data	13.6% 13.4% 17.9% 15.6% 12.4%	0 0 1 0 1	0 0 6 (0.91) 0 12 (0.96)	3.6 (0.67)
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	1992-96	observer data	10-18%	0,0,0,0,0	0,0,0,0,0	0
Total annual takes						3.6 (0.67)

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 five years, the annual mortality due to fisheries and ship strikes (3.6) is less than the calculated PBR for this stock (4.0), so they are not 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.

REFERENCES

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon, and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Southwest Fisheries Science Center Administrative Report. LJ-97-11. 25pp.

Barlow, J., K. A. Forney, P. S. Hill, R. L. Brownell, Jr., J. V. Carretta, D. P. DeMaster, F. Julian, M. S. Lowry, T. Ragen, and R. R. Reeves. 1997. U.S. Pacific Marine Mammal Stock Assessments: 1996. NOAA Technical Memorandum NOAA-TM-NMFS-SWFC-248. 223pp.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fish. Bull. 93:1-14.

Barlow, J., R. W. Baird, J. E. Heyning, K. Wynne, A. M. Manville, II, L. F. Lowry, D. Hanan, J. Sease, and V. N. Burkanov. 1994. A review of cetacean and pinniped mortality in coastal fisheries along the west coast of the U.S. and Canada and the east coast of the Russian Federation. Rep. Int. Whal. Commn, Special Issue 15:405-425.

Barlow, J. and T. Gerrodette. 1996. Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-233.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Brueggeman, J. J., G. A. Green, K. C. Balcomb, C. E. Bowlby, R. A. Grotefendt, K. T. Briggs, M. L. Bonnell, R. G. Ford, D. H. Varoujean, D. Heinemann, and D. G. Chapman. 1990. Oregon-Washington Marine Mammal and Seabird Survey: Information synthesis and hypothesis formulation. U.S. Department of the Interior, OCS Study MMS 89-0030.

Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-83: Status, abundance, and distribution. Final Report to the Minerals Management Service, Contract No. 14-12-0001-29090. 284p.

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

Dorsey, E. M., S. J. Stern, A. R. Hoelzel, and J. Jacobsen. 1990. Minke whale (Balaenoptera acutorostrata) from the west coast of North America: individual recognition and small-scale site fidelity. Rept. Int. Whal. Commn., Special Issue 12:357-368.

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

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Ch. 1 In: J. J. Brueggeman (ed.). Oregon and Washington Marine Mammal and Seabird Surveys. Minerals Management Service Contract Report 14-12-0001-30426.

Hanan, D. A. 1986. California Department of Fish and Game coastal marine mammal study, annual report for the period July 1, 1983 - June 30, 1984. Admin. Rept. LJ-86-16 available from Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA. 55pp.

Hanan, D. A., D. B. Holts, and A. L. Coan, Jr. 1993. The California drift gill net fishery for sharks and swordfish, 1981-82 through 1990-91. Calif. Dept. Fish and Game Fish. Bull. No. 175. 95pp.

Heyning, J. E., and T. D. Lewis. 1990. Fisheries interactions involving baleen whales off southern California. Rep. int. Whal. Commn. 40:427-431.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: preliminary estimates for 1996. Int. Whal. Commn. Working Paper SC/49/SM2. 13pp.

Julian, F. and M. Beeson. 1998. Estimates for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fishery Bulletin 96:271-284.

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

Pierce, D. J., M. Alexandersdottie, S. J. Jeffries, P. Erstad, W. Beattie, and A. Chapman. 1996. Interactions of marbled murrelets and marine mammals with the 1994 Puget Sound sockeye gill net fishery. Final Report, Wash. Dept. Fish and Wildlife, Olympia, WA. 21pp.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

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

Tershy, B. R., D. Breese, and C. S. Strong. 1990. Abundance, seasonal distribution and population composition of balaenopterid whales in the Canal de Ballenas, Gulf of California, Mexico. Rept. Int. Whal. Commn., Special Issue 12:369-375.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rept. Int. Whal. Commn. 43:477-493.

Appendix 1. Summary of 1998 Pacific marine mammal stock assessment reports for stocks that are under NMFS jurisdiction.

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality	Annual Fish. Mortality	Strategic Status
Harbor seal	Oregon/ Washington coast	PAC	AKC	24,733	0.12	1.0	1,484	19	17	N
Harbor seal	Inland Washington	PAC	AKC	16,104	0.12	1.0	966	41	36	N
Northern fur seal	San Miguel Island	PAC	AKC	6,720	0.086	1.0	270	0.0	0.0	N
Harbor porpoise	Oregon/ Washington coast	PAC	AKC	22,046	0.04	0.5	220	17	17	N
Harbor porpoise	Inland Washington	PAC	AKC	2,545	0.04	0.4	20	16	16	N
Mesoplodont beaked whales	California/ Oregon/ Washington	PAC	SWC	2,840[1]	0.04	0.45	26[2]	9.2-13	9.2-13	N
Minke whale	California/ Oregon/ Washington	PAC	SWC	440	0.04	0.45	4.0	3.6	3.6	N

[1] This value includes a species-specific minimum abundance estimate of 123 Blainville's beaked whales, Mesoplodon densirostris.

[2] This PBR includes 1.1 Blainville’s beaked whales.

Appendix 2. Review of new and prior information on the status of Pacific marine mammal stocks that are under NMFS jurisdiction. Most cetacean abundances in CA/OR/WA were updated with data from a 1996 survey (Barlow 1997). Total annual mortality estimates in CA/OR/WA were updated with fishery observer data averaged for 1992-1996 (Julian 1997; Julian and Beeson, in press). Total annual mortality was compared to a putative PBR calculated from Nmin, Rmax, and Fr values given below to determine whether strategic status changed for any of these stocks. N/A indicates that data are not available. Stocks for which new assessment reports were written in 1998 are indicated by **bold** font.

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	Total Annual Mortality	Annual Fish. Mortality
California sea lion	U.S.	PAC	SWC	111,339	0.12	1.0	974	915
Harbor seal	California	PAC	SWC	27,962	0.12	1.0	243	234
Harbor seal	**Oregon & Washington coast**	**PAC**	**AKC**	**24,733**	**0.12**	**1.0**	**19**	**17**
Harbor seal	**Inland Washington**	**PAC**	**AKC**	**16,104**	**0.12**	**1.0**	**41**	**36**
Northern elephant seal	California breeding	PAC	SWC	51,625	0.083	1.0	145	145
Guadalupe fur seal	Mexico to California	PAC	SWC	3,028	0.137	0.5	0.0	0.0
Northern fur seal	**San Miguel Island**	**PAC**	**AKC**	**6,720**	**0.086**	**1.0**	**0.0**	**0.0**
Hawaiian monk seal	Hawaii	PAC	SWC	1,366	0.07	0.1	N/A	N/A
Harbor porpoise	Central California	PAC	SWC	3,431	0.04	0.48	14	14
Harbor porpoise	Northern California	PAC	SWC	7,640	0.04	0.5	0.0	0.0
Harbor porpoise	**Oregon & Washington coast**	**PAC**	**AKC**	**22,046**	**0.04**	**0.50**	**17**	**17**
Harbor porpoise	**Inland Washington**	**PAC**	**AKC**	**2,545**	**0.04**	**0.4**	**16**	**16**
Dall's porpoise	California/ Oregon/ Washington	PAC	SWC	81,061	0.04	0.48	23	23
Pacific white-sided dolphin	California/ Oregon/ Washington	PAC	SWC	10,059	0.04	0.48	17	17
Risso's dolphin	California/ Oregon/ Washington	PAC	SWC	13,087	0.04	0.5	27	27
Bottlenose dolphin	California coastal	PAC	SWC	134	0.04	0.5	0.0	0.0

Appendix 2. Review of New Stock Assessment Information

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	Total Annual Mortality	Annual Fish. Mortality
Bottlenose dolphin	California/ Oregon/ Washington offshore	PAC	SWC	850	0.04	0.4	4.4	4.4
Striped dolphin	California/ Oregon/ Washington	PAC	SWC	17,943	0.04	0.4	1.2	1.3
Common dolphin, short-beaked	California/ Oregon/ Washington	PAC	SWC	318,446	0.04	0.5	231	2315
Common dolphin, long-beaked	California	PAC	SWC	27,832	0.04	0.48	14	14
Northern right whale dolphin	California/ Oregon/ Washington	PAC	SWC	10,059	0.04	0.5	38	38
Killer whale	California/ Oregon/ Washington	PAC	SWC	600	0.04	0.4	1.2	1.2
Killer whale	Southern Resident Stock	PAC	AKC	96	0.04	1.0	0.0	0.0
Pilot whale, short-finned	California/ Oregon/ Washington	PAC	SWC	717	0.04	0.4	13	13
Baird's beaked whale	California/ Oregon/ Washington	PAC	SWC	312	0.04	0.4	1.2	1.2
Mesoplodont beaked whales	**California/ Oregon/ Washington**	**PAC**	**SWC**	**2,840**	**0.04**	**0.45**	**9.2-13**	**9.2-13**
Cuvier's beaked whale	California/ Oregon/ Washington	PAC	SWC	4,980	0.04	0.5	26	26
Pygmy sperm whale	California/ Oregon/ Washington	PAC	SWC	1,920	0.04	0.45	2.8	2.8
Dwarf sperm whale	California/ Oregon/ Washington	PAC	SWC	N/A	0.04	0.5	0.0	0.0
Sperm whale	California/ Oregon/ Washington	PAC	SWC	995	0.04	0.1	4.6	4.6
Humpback whale	California/ Oregon/ Mexico	PAC	SWC	563	0.04	0.1	1.8	1.2

Appendix 2. Review of New Stock Assessment Information

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	Total Annual Mortality	Annual Fish. Mortality
Blue whale	California/ Mexico	PAC	SWC	1,463	0.04	0.1	0.2	0.0
Fin whale	California/ Oregon/ Washington	PAC	SWC	1,044	0.04	0.1	<1	0.0
Bryde's whale	Eastern Tropical Pacific	PAC	SWC	11,163	0.04	0.5	0.0	0.0
Sei whale	Eastern North Pacific	PAC	SWC	N/A	0.04	0.1	0.0	0.0
Minke whale	**California/ Oregon/ Washington**	**PAC**	**SWC**	**440**	**0.04**	**0.45**	**3.6**	**3.6**
Rough-Toothed dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Risso's dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Bottlenose dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Pantropical spotted dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Spinner dolphin	Hawaii	PAC	SWC	677	0.04	0.5	N/A	N/A
Striped dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Melon-headed whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Pygmy killer whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
False killer whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Killer whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Pilot whale, short-finned	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Blainville's beaked whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Cuvier's beaked whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Pygmy sperm whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Dwarf sperm whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A
Sperm whale	Hawaii	PAC	SWC	N/A	0.04	0.1	N/A	N/A
Blue whale	Hawaii	PAC	SWC	N/A	0.04	0.1	N/A	N/A

Appendix 2. Review of New Stock Assessment Information

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	Total Annual Mortality	Annual Fish. Mortality
Fin whale	Hawaii	PAC	SWC	N/A	0.04	0.1	N/A	N/A
Bryde's whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A

REFERENCES

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon, and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Southwest Fisheries Science Center Administrative Report. LJ-97-11. 25pp.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: preliminary estimates for 1996. Int. Whal. Commn. Working Paper SC/49/SM2. 13pp.

Julian, F. and M. Beeson. 1998. Estimates for marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fishery Bulletin 96:271-284.