Revised 12/15/98

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

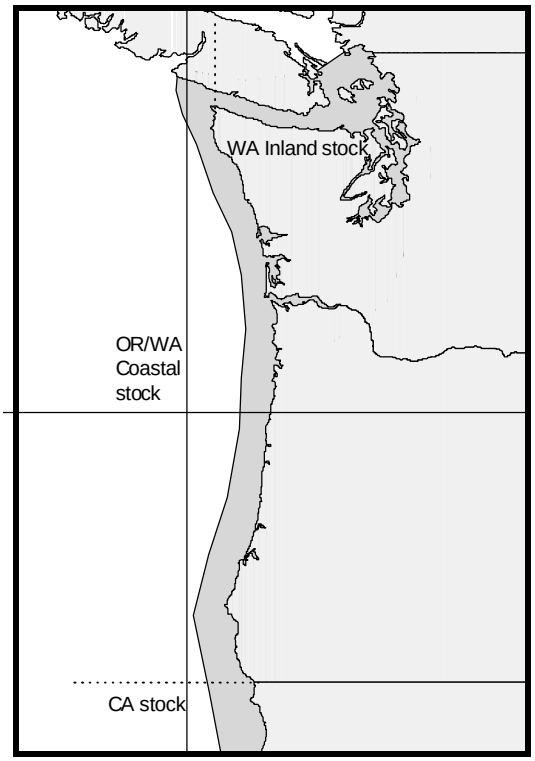

Figure 1. Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

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

POPULATION SIZE

Aerial surveys of harbor seals in Washington were conducted during the pupping season in 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	$\geq$1.6
Minimum total annual mortality						$\geq$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.