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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the continental U.S., British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944; Fisher 1952; Bigg 1969, 1981). Harbor seals do not make extensive pelagic migrations, though some long distance movement of tagged animals in Alaska (174 km) and along the U.S. west coast (up to 550 km) have been recorded (Pitcher and McAllister 1981, Brown and Mate 1983, Herder 1986). Harbor seals have also displayed strong fidelity for haulout 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 three separate harbor seal stocks along the west coast of the continental U.S. (Boveng 1988): 1) inland waters of Washington State (including Hood Canal, Puget Sound, and the Strait of Juan de Fuca out to Cape Flattery), 2) outer coast of Oregon and Washington, and 3) California (see Fig. 1). Genetic analyses provide additional support for this stock structure (Huber et al. 1994, 2010; 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 Washington inland waters possess unique haplotypes not found in seals from the coasts of Washington, Oregon, and California (Lamont et al. 1996). Recent genetic evidence suggests that the population of harbor seals in Washington inland waters has more structure than is currently recognized (Huber et al. 2010). In this report, only the Washington Inland Waters stock is addressed. Harbor seal stocks that occur in the inland and coastal waters of Alaska are reported separately in the Stock Assessment Reports for the Alaska Region.

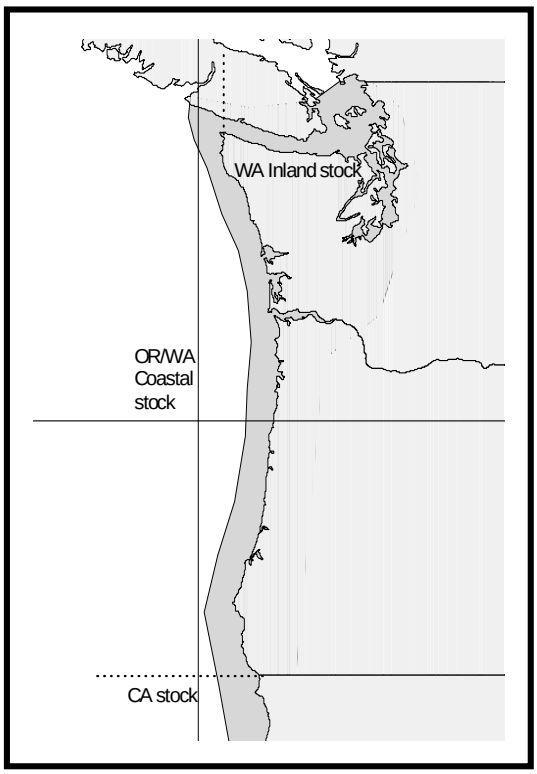

Figure 1. Approximate distribution of harbor seals in the U.S. Pacific Northwest (shaded area). Stock boundaries separating the three stocks are shown.

POPULATION SIZE

Aerial surveys of harbor seals in Washington were conducted during the pupping season in 1999, during which time the total numbers of hauled-out seals (including pups) were counted. In 1999, the mean count of harbor seals occurring in Washington's inland waters was 9,550 (CV=0.14) animals (Jeffries et al. 2003).

Radio-tagging studies conducted at six locations (three Washington inland waters sites and three Oregon and Washington coastal sites) collected information on haulout patterns from 63 harbor seals in 1991 and 61 harbor seals in 1992. Data from coastal and inland sites were not significantly different and were thus pooled, resulting in a correction factor of 1.53 (CV=0.065) to account for animals in the water which are missed during the aerial surveys (Huber et al. 2001). Using this correction factor results in a population estimate of 14,612 (9,550 x 1.53; CV=0.15) for the Washington Inland Waters stock of harbor seals (Jeffries et al. 2003). However, because the most recent abundance estimate is >8 years old, there is no current estimate of abundance.

Minimum Population Estimate

No current information on abundance is available to obtain a minimum population estimate for the Washington Inland Waters stock of harbor seals.

Current Population Trend

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

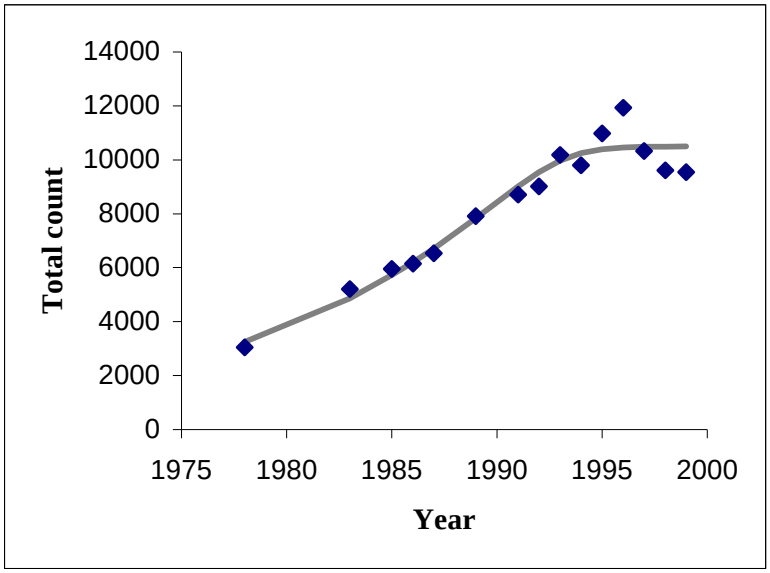

Figure 2. Generalized logistic population growth curve for the Washington Inland Waters stock of harbor seals, 1978-1999 (Jeffries et al. 2003).

Between 1983 and 1996, the annual rate of increase for this stock was 6% (Jeffries et al. 1997). The peak count occurred in 1996 and, based on a fitted generalized logistic model (Fig. 2), the population is thought to be stable (Jeffries et al. 2003).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

From 1991 to 1996, counts of harbor seals in Washington State have increased at an annual rate of 10% (Jeffries et al. 1997). Because the population was not at a very low level by 1991, the observed rate of increase may underestimate the maximum net productivity rate (R_{MAX}). When a logistic model was fit to the 1978-1999 abundance data, the resulting estimate of R_{MAX} was 12.6% (95% CI = 9.4-18.7%) (Jeffries et al. 2003). This value of R_{MAX} is very close to the default pinniped maximum theoretical net productivity rate of 12% (R_{MAX}), therefore, 12% will be employed for this harbor seal stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Because there is no current estimate of minimum abundance, a potential biological removal (PBR) cannot be calculated for this stock.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Fishing effort in the northern Washington marine gillnet tribal fishery is conducted within the range of both stocks of harbor seals (Oregon/Washington Coast and Washington Inland Waters) occurring in Washington State waters. Some movement of animals between Washington's coastal and inland waters is likely, although data from tagging studies have not shown movement of harbor seals between the two locations (Huber et al. 2001). For the purposes of this stock assessment report, the animals taken in waters east of Cape Flattery, WA, are assumed to have belonged to the Washington Inland Waters stock, and Table 1 includes data only from that portion of the fishery. There was no observer coverage in the northern Washington marine set gillnet tribal fishery in inland waters in 2004-2008; however, there were two fisher self-reports of harbor seal deaths in this fishery in 2008 (Makah Fisheries Management, unpublished data). The mean estimated mortality for this fishery in 2004-2008 is 0.4 harbor seals per year from fisher self-reports. Fishing effort in the northern Washington marine drift gillnet tribal fishery in inland waters is also conducted within the range of the Washington Inland Waters stock of harbor seals. This fishery is not observed; however, there was one fisher self-report of a harbor seal death in 2008 (Makah Fisheries

Management, unpublished data). The mean estimated mortality for this fishery in 2004-2008 is 0.2 harbor seals per year from fisher self-reports.

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

Table 1. Summary of available information on the incidental mortality and injury of harbor seals (Washington Inland Waters stock) in commercial and tribal fisheries that might take this species and calculation of the mean annual mortality rate; n/a indicates that data are not available. All entanglements resulted in the death of the animal. Mean annual takes are based on 2004-2008 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery in inland waters)	2004 2005 2006 2007 2008	observer data	0% 0% 0% 0% 0%	n/a n/a n/a n/a n/a	n/a n/a n/a n/a n/a	n/a
	2008	fisher self-reports		2	n/a	≥0.4 (n/a)
Northern WA marine drift gillnet (tribal fishery in inland waters)	2008	fisher self-reports		1	n/a	≥0.2 (n/a)
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)	1993	observer data	1.3%	2	n/a	see text
Puget Sound non-treaty chum salmon gillnet (areas 10/11 and 12/12B)[1]	1994	observer data	11%	1	10	see text[1]
Puget Sound treaty chum salmon gillnet (areas 12, 12B, and 12C)[1]	1994	observer data	2.2%	0	0	see text[1]
Puget Sound treaty chum and sockeye salmon gillnet (areas 4B, 5, and 6C)[1]	1994	observer data	7.5%	0	0	see text[1]
Puget Sound treaty and non-treaty sockeye salmon gillnet (areas 7 and 7A)[1]	1994	observer data	7%	1	15	see text[1]
Unknown Puget Sound fisheries	2004-2008	stranding data	n/a	1, 0, 0, 8, 6	n/a	≥3.0 (n/a)
Minimum total annual takes						≥3.6 (n/a)

[1]This fishery has not been observed since 1994 (see text); these data are not included in the calculation of recent minimum total annual takes.

In 1994, NMFS, in conjunction with WDFW conducted an observer program during the Puget Sound non-treaty chum salmon gillnet fishery (areas 10/11 and 12/12B). A total of 230 sets were observed during 54 boat trips, representing approximately 11% observer coverage of the 500 fishing boat trips comprising the total effort in this

fishery, as estimated from fish ticket landings (Erstad et al. 1996). One harbor seal was taken in the fishery, resulting in an entanglement rate of 0.02 harbor seals per trip (0.004 harbor seals per set), which extrapolated to approximately 10 deaths for the entire fishery. The Puget Sound treaty chum salmon gillnet fishery in Hood Canal (areas 12, 12B, and 12C) and the Puget Sound treaty sockeye/chum gillnet fishery in the Strait of Juan de Fuca (areas 4B, 5, and 6C) were also monitored in 1994 (NWIFC 1995). No harbor seal mortality was reported in the observer programs covering these treaty salmon gillnet fisheries, where observer coverage was estimated at 2.2% (based on % of total catch observed) and approximately 7.5% (based on % of observed trips to total landings), respectively.

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

It should be noted that the 1994 observer programs did not sample all segments of the 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. The percentage of the overall Washington Puget Sound Region salmon set/drift gillnet fishery effort that was observed in 1994 was not quantified. However, the areas having the highest salmon catches and in which a majority of the vessels operated in 1994 were covered by the 1994 observer programs (Joe Scordino, pers. comm.). Harbor seal takes in the Washington Puget Sound Region salmon drift gillnet fishery are unlikely to have increased since the fishery was last observed in 1994, due to reductions in the number of participating vessels and available fishing time (see details in Appendix 1). Fishing effort and catch have declined throughout all salmon fisheries in the region due to management efforts to recover ESA-listed salmonids.

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

Combining the estimates from the northern Washington marine set gillnet tribal fishery (0.4) and the northern Washington marine drift gillnet tribal fishery (0.2), results in an estimated mean annual mortality rate of 0.6 harbor seals from this stock. One harbor seal also entangled in a tribal drift gillnet test fishery in area 8-2 in 2006, resulting in an annual mortality of 0.2 harbor seals for this fishery.

The Marine Mammal Authorization Program (MMAP) fisher self-reports, required of commercial vessel operators by the MMPA, are an additional source of information on the number of harbor seals killed or seriously injured incidental to commercial fishery operations. Between 2004 and 2008, there were no fisher self-reports of harbor seal deaths from the Washington Puget Sound Region salmon set/drift gillnet fishery. Unlike the 1994 observer program data, the self-reported fishery data cover the entire fishery (including treaty and non-treaty components). Although these reports are considered incomplete (see details in Appendix 1), they represent a minimum mortality.

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. According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region (NMFS, Northwest Regional Office, unpublished data), there were 15 fishery-related strandings of harbor seals from this stock reported in 2004-2008, resulting in an average annual mortality of 3.0 harbor seals. Evidence of fishery interactions included entanglements in fishing nets (10), entanglements in fishing gear (three), hook injuries (one), and ingested hooks (one). As the strandings could not be attributed to a particular fishery, they have been included in Table 1 as occurring in unknown Puget Sound fisheries. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

Other Mortality

According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region (NMFS, Northwest Regional Office, unpublished data), a total of 46 human-caused harbor seal deaths or serious injuries were reported from non-fisheries sources in 2004-2008. Twenty-four animals were shot, 13 were struck by boats, two died in oil spills, three were killed by dogs, one was beaten by a fisherman, one was caught in the Ballard Locks, one entangled in wire, and one entangled in a scientific research capture net, resulting in an

estimated mortality of 9.2 harbor seals per year from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).

Subsistence Harvests by Northwest Treaty Indian Tribes

Tribal subsistence takes of this stock may occur, but no data on recent takes are available.

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 is 13.0 (3.8 + 9.2) harbor seals per year. A PBR cannot be calculated for this stock because there is no current abundance estimate. The previous estimate of PBR was 771 (Carretta et al. 2009). Human-caused mortality relative to PBR is unknown, but it is considered to be small relative to the stock size. Therefore, the Washington Inland Waters stock of harbor seals is not classified as a "strategic" stock. At present, the minimum estimated fishery mortality and serious injury for this stock is 3.8 (based on recent observer data (0) and self-reported fisheries information (0.8) or stranding data (3.0) where observer data were not available or failed to detect harbor seal mortality). Since a PBR cannot be calculated for this stock, fishery mortality relative to PBR is unknown. The stock is within its Optimum Sustainable Population (OSP) level (Jeffries et al. 2003).

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:* Ridgway, S. H., and R. J. Harrison (eds.), Handbook of Marine Mammals. Vol. 2: Seals. Academic Press, New York.

Boveng, P. 1988. Status of the Pacific harbor seal population on the U.S. west coast. Administrative Report LJ-88-06. 43 pp. Available from Southwest Fisheries Science Center, 3333 North Torrey Pines Road, La Jolla, CA 92037.

Brown, R. F. 1988. Assessment of pinniped populations in Oregon: April 1984 to April 1985. NWAFC Processed Report 88-05. 44 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

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, University of British Columbia, Vancouver, BC. 77 pp.

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

Carretta, J. V., K. A. Forney, M. S. Lowry, J. Barlow, J. Baker, D. Johnston, B. Hanson, M. M. Muto, D. Lynch, and L. Carswell. 2009. U.S. Pacific marine mammal stock assessments: 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-434. 336 pp.

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

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

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 University, Humbolt, CA. 52 pp.

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

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

Huber, H. R., S. J. Jeffries, D. M. Lambourn, and B. R. Dickerson. 2010. Population substructure of harbor seals (*Phoca vitulina richardsi*) in Washington State using mtDNA. Can. J. Zool. 88:280-288.

Jeffries, S. J. 1985. Occurrence and distribution patterns of marine mammals in the Columbia River and adjacent coastal waters of northern Oregon and Washington. Pp. 15-50, *In:* Beach, R. J., A. C. Geiger, S. J. Jeffries, S. D. Treacy, and B. L. Troutman, Marine mammals and their interactions with fisheries of the Columbia River and adjacent waters, 1980-1982. NWAFC Processed Report 85-04. 316 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

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

Jeffries, S., H. Huber, J. Calambokidis, and J. Laake. 2003. Trends and status of harbor seals in Washington State: 1978-1999. J. Wildl. Manage. 67(1):208-219.

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.

Makah Fisheries Management, P.O. Box 115, Neah Bay, WA 98357.

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

National Marine Fisheries Service (NMFS), Northwest Regional Office, 7600 Sand Point Way NE, Seattle, WA 98115.

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

Northwest Indian Fisheries Commission (NWIFC). 1995. Monitoring of marbled murrelet and marine mammal interactions with 1994 tribal gillnet fisheries in northern Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Final Report to NMFS (Contract No. 52ABNF400087) and U.S. Fish and Wildlife Service. Unpublished Report. 41 pp. Available at NWIFC, 6730 Martin Way E, Olympia, WA 98516.

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

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

Pitcher, K. W., and D. G. Calkins. 1979. Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Report 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, Joe. National Marine Fisheries Service, Northwest Regional Office, 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 porpoises. MS Thesis, Oregon State University, Corvallis, OR.

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