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HARBOR SEAL (*Phoca vitulina*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The harbor seal is found in all nearshore waters of the Atlantic Ocean and adjoining seas above about 30°N (Katona et al. 1993). In the western North Atlantic, they are distributed from the eastern Canadian Arctic and Greenland south to southern New England and New York, and occasionally to the Carolinas (Mansfield 1967; Boulva and McLaren *1979*; Katona *et al.* 1993; Gilbert and Guldager 1998; Baird 2001). Stanley *et al.* (1996) examined worldwide patterns in harbor seal mitochondrial DNA, which indicate that western and eastern North Atlantic harbor seal populations are highly differentiated. Further, they suggested that harbor seal females are only regionally philopatric, thus population or management units are on the scale of a few hundred kilometers. Although the stock structure of the western North Atlantic population is unknown, it is thought that harbor seals found along the eastern U.S. and Canadian coasts represent one population (Temte *et al.* 1991). In U.S. waters, breeding and pupping normally occur in waters north of the New Hampshire/Maine border, although breeding occurred as far south as Cape Cod in the early part of the twentieth century (Temte *et al.* 1991; Katona *et al.* 1993).

Harbor seals are year-round inhabitants of the coastal waters of eastern Canada and Maine (Katona *et al.* 1993), and occur seasonally along the southern New England and New York coasts from September through late May (Schneider and Payne 1983). In recent years, their seasonal interval along the southern New England to New Jersey coasts has increased (Barlas 1999; Hoover *et al.* 1999; Slocum *et al.* 1999; Schroeder 2000; deHart 2002). Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data). A general southward movement from the Bay of Fundy to southern New England waters occurs in autumn and early winter (Rosenfeld *et al.* 1988; Whitman and Payne 1990; Barlas 1999; Jacobs and Terhune 2000). A northward movement from southern New England to Maine and eastern Canada occurs prior to the pupping season, which takes place from mid-May through June along the Maine Coast (Richardson 1976; Wilson 1978; Whitman and Payne 1990; Kenney 1994; deHart 2002). No pupping areas have been identified in southern New England (Payne and Schneider 1984; Barlas 1999). More recent information suggests that pupping is occurring at high-use haulout sites off Manomet, Massachusetts (B. Rubinstein, pers. comm., New England Aquarium). The overall geographic range throughout coastal New England has not changed significantly during the last century (Payne and Selzer 1989).

Prior to spring 2001 live capture and radio tagging of adult harbor seals, it was believed that the majority of seals moving into southern New England and mid-Atlantic waters were subadults and juveniles (Whitman and Payne 1990; Katona *et al.* 1993; Slocum *et al.* 1999). The 2001 study established that adult animals also made this migration. Seventy-five percent (9/12) of the tagged seals were detected at least once during the May/June 2001 abundance survey along the Maine coast (Gilbert *et al*. 2005; Waring *et al*. in press).

POPULATION SIZE

Since passage of the MMPA in 1972, the observed count of seals along the New England coast has been increasing. Coast-wide aerial surveys along the Maine coast were conducted in May/June 1981, 1986, 1993, 1997, and 2001during pupping. (Gilbert and Stein 1981; Gilbert and Wynne 1983, 1984; Kenney 1994; Gilbert and Guldager 1998; Gilbert *et al.* 2005). However, estimates older than eight years are deemed unreliable (Wade and Anglis 1997),, and therefore should not be used for PBR determinations. Therefore, only the 2001 estimate is useful for population assessment. The 2001 survey, conducted in May/June, included replicate surveys and radio tagged seals to obtain a correction factor for animals not hauled out. The corrected estimate for 2001 is 99,340 (23,722). The 2001 observed count of 38,014 is 28.7% greater than the 1997 count. Increased abundance of seals in the northeast region has also been documented during aerial and boat surveys of overwintering haul-out sites from the Maine/New Hampshire border to eastern Long Island and New Jersey (Payne and Selzer 1989; Rough 1995; Barlas 1999; Hoover *et al.* 1999; Slocum *et al.* 1999; deHart 2002).

Canadian scientists counted 3,500 harbor seals during an August 1992 aerial survey in the Bay of Fundy (Stobo and Fowler 1994), but noted that the survey was not designed to obtain a population estimate. The Sable Island population was the largest in eastern Canada in the late 1980s, however recently the number has drastically declined (Baird 2001). Similarly, pup production declined on Sable Island from 600 in 1989 to 30 in 1997 (Baird 2001).

Possible reasons for this decline may be increased use of the island by gray seals and increased predation by sharks (Stobo and Lucas 2000).

Table 1. Summary of abundance estimates for the western Atlantic harbor seal. Month, year, and area covered during each abundance survey, resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best} [a]	CV
May/June 2001	Maine coast	99,340 (23,722) [b]	CV=.097

[a] Pup counts are in brackets

[b] Corrected estimate based on uncorrected count of 38,011 (9,278)

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for harbor seals is 99,340 (CV=.097). The minimum population estimate is 91,546 based on corrected total counts along the Maine coast in 2001.

Current Population Trend

Between 1981 and 2001, the uncorrected counts of seals increased from 10,543 to 38,014, an annual rate of 6.6 percent (Gilbert *et al*. 2005).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this population. Based on uncorrected haulout counts over the 1981 to 2001 survey period, the harbor seal population is growing at approximately 6.6% (Gilbert *et al.* 2005). However, a population grows at the maximum growth rate (R_{MAX}) only when it is at a very low level; thus the 6.6% growth rate is not considered to be a reliable estimate of (R_{MAX}). For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate (½ of 12%), and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 91,546. The recovery factor (F_R) for this stock is 1.0, the value for stocks of unknown status, but known to be increasing. PBR for U.S. waters is 5,493.

ANNUAL HUMAN-CAUSED MORTALITY

For the period 2000-2004 the total human caused mortality and serious injury to harbor seals is estimated to be 925 per year. The average is derived from two components: 1) 906 (CV=0.18; Table 2) from the 2000-2004 observed fishery; and 2) 19 from average 2000-2004 stranding mortalities resulting from boat strikes, power plant entrainments, shooting, and other sources (NMFS unpublished data).

Researchers and fishery observers have documented incidental mortality in several fisheries, particularly within the Gulf of Maine (see below). An unknown level of mortality also occurred in the mariculture industry (i.e., salmon farming), and by deliberate shooting (NMFS unpublished data). However, no data are available to determine whether shooting still takes place.

Fishery Information

Detailed Fishery information is given in Appendix III.

U.S.

Northeast Sink Gillnet:

Annual estimates of harbor seal bycatch in the Northeast sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. The fishery has been observed in the Gulf of Maine and in southern New England (Williams 1999; NMFS unpublished data). There were 136 harbor seal mortalities observed in the Northeast sink gillnet fishery between 2000 and 2004. Estimated annual mortalities (CV in parentheses) from this fishery during 2000-2004 were 917 (0.43) in 2000, 1,471 (0.38) in 2001,787 (0.32) in 2002, 542 (0.28) in 2003 and 792 (0.34) in 2004 (Table 2). There were 5, 8, 2, 2, and 9 unidentified seals observed during 2000-2004, respectively. Since 1997, unidentified seals have not been prorated to a species. This is consistent with the treatment of other unidentified mammals that do not get prorated to a specific species. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 2000-2004 was 902 harbor seals (CV=0.18) (Table 2). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred in the Midcoast closure region (2) and east of Cape Cod (1) between January and April. Between May and August 6 animals were caught off Massachusetts and New Hampshire, and between September and December 4 were caught in the Midcoast closure area.

Mid-Atlantic Coastal Gillnet

Observed effort was distributed from New York to North Carolina year-round. One harbor seal was observed taken in 2004 off New Jersey. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 in 1995-1997 and 1999-2003 11 in 1998 (0.77), and 15 (0.86) in 2004. Average annual estimated fishery-related mortality attributable to this fishery during 2000-2004 was 4 (CV =0.86) harbor seals. In 2002, 65% of observer coverage was concentrated in one area and not distributed proportionally across the fishery. Therefore observed mortality is considered unknown in 2002.

Northeast Bottom Trawl

Vessels in the Northeast bottom trawl fishery, a Category III fishery under MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. In the 2005 list of fisheries (LOF) this fishery has been elevated to Category II. Four mortalities were observed between 2000 and 2004 (Table 2). Observer coverage, expressed as number of trips, was < 1% from 1998 to 2001, and 2% in 2002 (Table 2). The estimated annual fishery-related mortality and serious injury attributable to this fishery are currently being determined.

Gulf of Maine Atlantic Herring Purse Seine Fishery

The Gulf of Maine Atlantic Herring Purse Seine Fishery is a Category III fishery. This fishery was not observed until 2003. No mortalities have been observed, but 11 harbor seals were captured and released alive.

CANADA

Currently, scant data are available on bycatch in Atlantic Canada fisheries due to a lack of observer programs (Baird 2001). An unknown number of harbor seals have been taken in Newfoundland, Labrador, Gulf of St. Lawrence and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, Atlantic Canada cod traps, and in Bay of Fundy herring weirs (Read 1994). Furthermore, some of these mortalities (e.g., seals trapped in herring weirs) are the result of direct shooting.

Table 2. Summary of the incidental mortality of harbor seals (*Phoca vitulina*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [a]	Observer Coverage [b]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast [c] Sink Gillnet	00-04	301	Obs. Data, Weighout, Logbooks	.06, .04, .02, .03, .06	26, 32, 12, 21, 45	917, 1471, 787, 542, 792	.43, .38, .32, .28, .34	902 (0.18)
Mid-Atlantic Coastal Sink Gillnet	00-04	unk [d]	Obs. Data, Weighout	.02, .02, .01, .01, .02	0, 0, unk [e], 0, 1	0, 0, unk [e], 0, 15	0, 0, unk [e], 0, .86	4 (0.86) [e]
Northeast Bottom Trawl	00-04	unk	Obs. Data, Weighout	.01, .01, .03, .03, .05	0, 0, 4, 0, 0	0, 0, unk, 0, 0	0, 0, unk, 0, 0	unk
TOTAL								906 (0.18)

[a] Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Observer Program. NEFSC collects landings data (Weighout), and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of fishing effort in the Northeast sink gillnet fishery.

[b] The observer coverage for the Northeast sink gillnet fishery and the mid-Atlantic coastal gillnet fisheries are measured in tons of fish landed.

[c] Since 1998, takes from pingered and non-pingered nets within a marine mammal time/area closure that required pingers, and takes from pingered and non-pingered nets not within a marine mammal time/area closure were pooled. The pooled bycatch rate was weighted by the total number of samples taken from the stratum and used to estimate the mortality. In 2000 - 2004, respectively, 8, 10, 3, 0, 8 takes were observed in nets with pingers. In 2000 – 2004, respectively, 18, 22, 9, 21, 37 takes were observed in nets without pingers.

[d] Number of vessels is not known.

[e] Sixty-five percent of sampling in the mid-Atlantic coastal gillnet by the NEFSC fisheries observer program was concentrated in one area off the coast of Virginia. Because of the low level of sampling that was not distributed proportionately throughout the mid-Atlantic region observed mortality is considered unknown in 2002. The four year average (2000-2001, 2003, and 2004) estimated mortality was applied as the best representative estimate.

Other Mortality

Historically, harbor seals were bounty hunted in New England waters, which may have caused a severe decline of this stock in U.S. waters (Katona *et al.* 1993). Bounty hunting ended in the mid-1960s.

Currently, aquaculture operations in eastern Canada are licensed to shoot nuisance seals, but the number of seals killed is unknown (Baird 2001). Other sources of harbor seal mortality include human interactions, storms, abandonment by the mother, disease, and predation (Katona *et al.* 1993; Jacobs and Terhune 2000; NMFS unpublished data). Mortalities caused by human interactions include boat strikes, fishing gear interactions, power plant entrainment, oil spill/exposure, harassment, and shooting.

Small numbers of harbor seals strand each year throughout their migratory range. Stranding data provide insight into some of these sources of mortality. From 2000-2004, 2,059 harbor seal strandings were reported (219 in 2000, 246 in 2001, 337 in 2002, 479 in 2003, and 774 in 2004) in all states between Maine and North Carolina (Table 3; NMFS unpublished data). Ninety-nine (4.8%) of the seals stranded during this five year period showed signs of human interaction as a direct cause of mortality. An Unusual Mortality Event (UME) was declared for harbor seals in northern Gulf of Maine waters during 2004. Stranding data probably underestimate the extent of fishery-related mortality and serious injury because all of the marine mammals that die or are seriously injured may

not wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

Stobo and Lucas (2000) have documented shark predation as an important source of natural mortality at Sable Island, Nova Scotia. They suggest that shark-inflicted mortality in pups, as a proportion of total production, was less than 10% in 1980-1993, approximately 25% in 1994-1995, and increased to 45% in 1996. Also, shark predation on adults was selective towards mature females. They suggest that the combined predation mortality is likely impacting the Sable Island population growth, and may be contributing to the observed population decline.

Table 3. Harbor seal (*Phoca vitulina*) reported strandings along the U.S. Atlantic coast (2002-2004).

State	**2002**	**2003**	**2004**[c]	**Total**
Maine	183	259	509[a]	951
New Hampshire	3	15	24	42
Massachusetts	108	109	170	387
Rhode Island	4	12	12	28
Connecticut	0	1	3	4
New York	18	22	31	71
New Jersey	15	30	16[b]	61
Delaware	0	2	0	2
Maryland	0	2	1	3
Virginia	3	6	5	14
North Carolina	3	23	4	30
Florida	0	0	1	1
Total	337	481	776	1,594

[a] Unusual Mortality Event (UME) declared for harbor seals in northern Gulf of Maine waters during 2004.

[b] Harbor seals were treated and released in New Jersey.

[c] During 2004, the Northeast region had 37 seal strandings where species could not be determined. In 2004, 13 harbor seals had signs of human interaction.

STATUS OF STOCK

The status of the western North Atlantic harbor seal stock, relative to OSP, in the U.S. Atlantic EEZ is unknown, but the stock's abundance is increasing. The species is not listed as threatened or endangered under the Endangered Species Act. Total U.S. fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be approaching zero mortality and serious injury rate. This is not a strategic stock because human-related mortality and serious injury does not exceed PBR.

REFERENCES

Baird, R.W. 2001. Status of harbor seals, *Phoca vitulina*, in Canada. Can. Field Nat. 115:663-675.

Barlas, M.E. 1999. The distribution and abundance of harbor seals (*Phoca vitulina concolor*) and gray seals (*Halichoerus grypus*) in southern New England, winter 1998- summer 1999. MA Thesis, Boston University, Graduate School of Arts and Sciences., Boston, MA. 52 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K.D. 1997. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. Rep. int. Whal. Commn 47:705-14.

Boulva, J. and I.A. McLaren. 1979. Biology of the harbor seal, *Phoca vitulina*, in eastern Canada. Bull. Fish. Res. Bd. Can. 200:1-24.

Bravington, M.V. and K.D. Bisack. 1996. Estimates of harbor porpoise bycatch in the Gulf of Maine sink gillnet fishery, 1990-93. Rep. int. Whal. Commn 46:567-574.

deHart, P.A.P. 2002. The distribution and abundance of harbor seals (*Phoca vitulina concolor*) in the Woods Hole region. MA Thesis, Boston University, Graduate School of Arts and Sciences. Boston, MA, 88 pp.

Gilbert, J.R., G.T. Waring, K.M. Wynne, and N. Guldager. 2005. Changes in abundance and distribution of harbor seals in Maine, 1981-2001. Mar. Mammal Sci. 21:519-535.

Gilbert, J.R. and J.L. Stein. 1981. Harbor seal populations and marine mammal fisheries interactions, 1981. Annual report, Contract NA-80-FA-C-00029, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 35 pp.

Gilbert, J.R. and K.M. Wynne. 1983. Harbor seal populations and marine mammal fisheries interactions, 1982. Second annual report, Contract NA-80-FA-C-00029, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 43 pp.

Gilbert, J.R. and K.M. Wynne. 1984. Harbor seal populations and marine mammal fisheries interactions, 1983. Third annual report, Contract NA-80-FA-C-00029, to NMFS, Northeast Fisheries Science Center, 166 Water St, Woods Hole, MA. 52 pp.

Gilbert, J.R. and K.M. Wynne. 1985. Harbor seal populations and fisheries interactions with marine mammals in New England, 1984. Interim Rep., NOAA NA-84-EAC-00070, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 15 pp.

Gilbert, J.R. and K.M. Wynne. 1987. Marine mammal interactions with New England gillnet fisheries. Final Report, Contract No. NA-84-EAC-00070, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 21 pp.

Gilbert, J.R. and N. Guldager. 1998. Status of harbor and gray seal populations in northern New England. Final Report under NMFS/NER Cooperative Agreement 14-16-009-1557, to NMFS, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA. 13 pp.

Hoover, K., S. Sadove, and P. Forestell. 1999. Trends of harbor seal, *Phoca vitulina*, abundance from aerial surveys in New York waters: 1985-1999. Proceedings of the 13th Biennial Conference on the Biology of Marine , Wailea, Hawaii, Nov. 28 - Dec. 3, 1999. (Abstract).

Jacobs, S.R. and J.M. Terhune. 2000. Harbor seal (*Phoca vitulina*) numbers along the New Brunswick coast of the Bay of Fundy in autumn in relation to aquaculture. Northeastern Naturalist 7(3): 289-296.

Katona, S.K., V. Rough, and D.T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. Smithsonian Institution Press: Washington, DC, 316 pp.

Kenney, M.K. 1994. Harbor seal population trends and habitat use in Maine. M.S. Thesis. University of Maine, Orono, ME. 55 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. ICES C.M. 8/Q. 10 pp.

Mansfield, A.W. 1967. Distribution of the harbor seal, *Phoca vitulina* Linnaeus, in Canadian Arctic waters. J. Mamm. 48(2):249-257.

Payne. P.M. and D.C. Schneider. 1984. Yearly changes in abundance of harbor seals, *Phoca vitulina*, at a winter haul-out site in Massachusetts. Fish. Bull., U.S. 82:440-442.

Payne, P.M. and L.A. Selzer. 1989. The distribution, abundance and selected prey of the harbor seal, *Phoca vitulina concolor*, in southern New England. Mar. Mammal Sci. 5(2):173-192.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. Rep. int. Whal. Commn (Special Issue) 15:133-147.

Richardson, D.T. 1976. Assessment of harbor and gray seal populations in Maine 1974-1975. Final report, contract No. MM4AC009, Marine Mammal Commission., Washington, DC, 46 pp.

Rosenfeld M., M. George, and J.M. Terhune. 1988. Evidence of autumnal harbour seal, *Phoca vitulina*, movement from Canada to the United States. Can. Field Nat. 102(3):527-529.

Rough, V. 1995. Gray seals in Nantucket Sound, Massachusetts, winter and spring, 1994. Final report to Marine Mammal Commission, Contract T10155615, 28 pp. NTIS Pub. PB95-191391.

Schneider, D.C. and P.M. Payne. 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. J. Mamm. 64(3):518-520.

Schroeder, C.L. 2000. Population status and distribution of the harbor seal in Rhode Island waters. M.S. Thesis, University of Rhode Island, Kingston, RI. 197 pp.

Slocum, C.J., R. Schoelkopf, S. Tulevech, M. Stevens, S. Evert, and M. Moyer. 1999. Seal populations wintering in New Jersey (USA) have increased in abundance and diversity. Proceedings of the 13th Biennial Conference on the Biology of Marine Mammals, Wailea, Hawaii, Nov. 28 - Dec. 3, 1999. (Abstract).

Stanley, H.F., S. Casey, J.M. Carnahan, S. Goodman, J. Harwood, and R.K. Wayne. 1996. Worldwide patterns of mitochondrial DNA differentiation in the harbor seal (*Phoca vitulina*). Mol. Biol. Evol. 13:368-382.

Stobo, W.T. and G.M. Fowler. 1994. Aerial surveys of seals in the Bay of Fundy and off southwest Nova Scotia. Can. Tech. Rep. Fish. Aquat. Sci. 1943:57 pp.

Stobo, W.T. and Z. Lucas. 2000. Shark-inflicted mortality on a population of harbour seals (*Phoca vitulina*) at Sable Island, Nova Scotia. J. Zool. Lond. 252:405-414.

Temte, J.L., M.A. Bigg, and O. Wiig. 1991. Clines revisited: the timing of pupping in the harbour seal (*Phoca vitulina*). J. Zool. Lond. 224:617-632.

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

Waring, G.T., J.R. Gilbert, J. Loftin, and N. Cabana. 2006. Short term movements of radio tagged harbor seals in New England. Northeast. Nat. 13(1):1-14.

Whitman, A.A. and P.M. Payne. 1990. Age of harbour seals, *Phoca vitulina concolor*, wintering in southern New England. Can. Field Nat. 104(4):579-582.

Williams, A.S. 1999. Prey selection by harbor seals in relation to fish taken by the Gulf of Maine sink gillnet fishery. M.S. Thesis University of Maine, Orono, ME. 62 pp.

Wilson, S.C. 1978. Social organization and behavior of harbor seals, *Phoca concolor*, in Maine. Final Report contract MM6ACO13, GPO-PB-280-188, Marine Mammal Commission, Washington, DC, 36 pp.