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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 30^0N (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 Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data).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, including a pregnant female, in Chatham, Massachusetts (Waring *et al*. in press), it was believed that the majority of seals moving into southern New England and Mid-Atlantic waters are subadults and juveniles (Whitman and Payne 1990; Katona *et al.* 1993; Slocum *et al.* 1999). 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. Five coast-wide aerial surveys along the Maine coast have been conducted in May/June during pupping. Uncorrected counts, with number of pups in parentheses, between 1981 and 2001 were 10,543 (676) in 1981, 12,940 (1,713) in 1986, 29,538 (4,257) in 1993, 31,078 (5,395) in 1997 and 38,014 (9,282) in 2001 (Table 1; Gilbert and Stein 1981; Gilbert and Wynne 1983, 1984; Kenney 1994; Gilbert and Guldager 1998; Gilbert *et al.* 2005). As recommended in the GAMMS Workshop Report (Wade and Anglis 1997), estimates older than eight years are deemed unreliable, and therefore should not be used for PBR determinations. 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). Prior to 2001, the numbers are considered to be a minimum abundance estimate because they are uncorrected for animals in the water or outside the survey area. In addition, the surveys conducted in 1981 and 1986 were conducted in late June, after peak pupping. 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 1980's, 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 1997	Maine coast	31,078 (5,395)	None reported
May/June	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).

Possible factors contributing to harbor seal population increase include MMPA protection, fishery management regulations (e.g., closed areas, fishing effort reduction) designed to rebuild groundfish stocks, and possible increased food availability.

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 1999-2003, the total human caused mortality and serious injury to harbor seals is estimated to be 1,051 per year. The average is derived from two components: 1) 1,032 (CV=0.17 ; Table 2) from the 1999-2003 observed fishery; and 2) 19 from average 1999-2003 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.

Earlier Interactions

Incidental takes of harbor seals have been recorded in groundfish gillnet, herring purse seine, halibut tub trawl, and lobster fisheries (Gilbert and Wynne, 1985 and 1987). A study conducted by the University of Maine reported a combined average of 22 seals entangled annually by 17 groundfish gillnetters off the coast of Maine (Gilbert and Wynne 1987). All seals were young of the year and were caught from late June through August and in early October. Interviews with a limited number of mackerel gillnetters indicated only one harbor seal entanglement and a negligible loss of fish to seals.

Net damage and fish robbing were not reported to be a major economic concern to gillnetters interviewed (Gilbert and Wynne 1987).

Herring purse seiners have reported accidentally entrapping seals off the mid-coast of Maine, but indicated that the seals were rarely drowned before the seine was emptied (Gilbert and Wynne 1985). Capture of seals by halibut tub trawls is rare. One vessel captain indicated that he took one or two seals a year. These seals were all hooked through the skin and released alive, indicating they were snagged as they followed baited hooks. Infrequent reports suggest seals may rob bait off longlines, although this loss is considered negligible (Gilbert and Wynne 1985).

Incidental takes in lobster traps in inshore waters off Maine are reportedly rare. Captures of approximately two seal pups per port per year were recorded by mid-coastal lobstermen off Maine (Gilbert and Wynne 1985). Seals have been reported to rob bait from inshore lobster traps, especially in the spring, when fresh bait is used. These incidents may involve only a few individual animals. Lobstermen claim that seals consume shedding lobsters, but there are no data to support this.

Current

Commercial fisheries observed for harbor seal bycatch are the Northeast Sink Gillnet, Mid-Atlantic Coastal Gillnet, and North Atlantic Bottom Trawl fisheries.

Northeast Sink Gillnet

The fishery has been observed in the Gulf of Maine and in southern New England (Williams 1999; NMFS unpublished data). There were 427 harbor seal mortalities observed in the Northeast sink gillnet fishery between 1990 and 2003, excluding three animals taken in the 1994 pinger experiment (NMFS unpublished data). Williams (1999) aged 261 harbor seals caught in this fishery from 1991 to 1997, and 93% were juveniles (e.g. less than four years old). Annual estimates of harbor seal bycatch in the Northeast sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1999-2003 were 332 in 1998 (0.33), 1,446 in 1999 (0.34), 917 (0.43) in 2000, 1,471 (0.38) in 2001,787 (0.32) in 2002, and 542 (0.28) in 2003 (Table 2). There were 1, 5, 8, 2, and 2 unidentified seals observed during 1999-2003, 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 1999-2003 was 1,032 harbor seals (CV=0.17) (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

No harbor seals were taken in observed trips during 1993-1997, and 1999-2003. Two harbor seals were observed taken in 1998. Observed effort was concentrated off New Jersey and scattered between Delaware and North Carolina from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 in 1995-1997 and 1999-2003 and 11 in 1998 (0.77). Average annual estimated fishery-related mortality attributable to this fishery during 1999-2003 was zero 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.

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. No mortalities were observed between 1991-2001; 4 mortalities were observed in 2002 (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.

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.

In 1996, observers recorded 7 harbor seals (one released alive) in Spanish deep-water trawl fishing on the southern edge of the Grand Banks (NAFO Areas 3) (Lens 1997). Seal bycatches occurred year-round, but interactions were highest

during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

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			Observer Coverage[b]	Observed Mortality			Mean Annual Mortality
Northeast [c] Sink Gillnet	99-03	301	Obs. Data Weighout, Logbooks	.06, .06, .04, .02, .03	49, 26, 32, 12, 21	1446, 917, 1471, 787, 542	.34, .43, .38, .32, .28	1032 (0.17)
Mid-Atlantic Coastal Sink Gillnet	99-03	unk[d]	Obs. Data Weighout	.02, .02, .02, .01, .01	0, 0, 0, unk[5], 0	0, 0, 0, unk[e], 0	0, 0, 0, unk[e] , 0	[e] 0 (0)
North Atlantic Bottom Trawl	99-03	TBD	Obs. Data Weighout	.003, .004, .004, .021, tbd	0, 0, 0, 4, 0	0, 0, 0, tbd[f], 0	0, 0, 0, tbd[f], 0	TBD[f]
TOTAL								1032 (0.17)

a Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling 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 effort for the Northeast sink gillnet fishery is measured in trips. Observer coverage of the Mid-Atlantic coastal gillnet fishery is measured in tons of fish landed.

c In 1997, 1998, 1999, 2000 and 2001 respectively, observed mortality on "marine mammal trips" was 43, 13, 45, 26 and 27 animals. Only these mortalities were used to estimate total harbor seal bycatch. See Bisack (1997) for "trip" type definitions. From 1997 to 2001, respectively, 1, 2, 4, 3 and 5 harbor seals were observed on dedicated fish sampling trips. From 1997 to 2001, respectively, 14, 1, 5, 8 and 10 harbor seals were observed taken in nets equipped with pingers. Since 1998, takes from non-pingered nets within a marine mammal time/area closure that required pingers, and takes from pingered nets not within a marine mammal time/area closure that did not required pingers were pooled with the takes from nets with and without pingers from the same stratum. The pooled bycatch rate was weighted by the total number of samples taken from the stratum and used to estimate the mortality.

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 (1999-2001, and 2003) estimated mortality was applied as the best representative estimate.

f Estimating mortality attributed to the North Atlantic bottom trawl fishery is in progress.

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-1960's.

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 1999-2003, 1,432 harbor seal strandings were reported (150 in 1999, 219 in 2000, 246 in 2001, 337 in 2002, and 481 in 2003) in all states between Maine and North Carolina (Table 3; NMFS unpublished data). Ninety-nine (6.9%) of the seals stranded during this five year period showed signs of human interaction as a direct cause of mortality.

Table 3. Harbor seal (*Phoca vitulina*) reported strandings along the U.S. Atlantic coast (2002-2003).

STATE	2002	2003	TOTAL
Maine	183	259	442
New Hampshire	3	15	18
Massachusetts	108	109	217
Rhode Island	4	12	16
Connecticut	0	1	1
New York	18	22	40
New Jersey	15	30	45
Delaware	--	2	2
Maryland	--	2	2
Virginia	3	6	9
North Carolina	3	23	26
Total	337	481	818

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.

STATUS OF STOCK

The status of harbor seals, relative to OSP, in the U.S. Atlantic EEZ is unknown, but the population is increasing. The species is not listed as threatened or endangered under the Endangered Species Act. Gilbert *et al.* 2005 estimated a 6.6% annual rate of increase of this stock in Maine coastal waters based on 1981 to 2001 surveys conducted along the Maine coast. The population is increasing despite the known fishery-related and other human sources of mortality. Total 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 fishery-related mortality and serious injury does not exceed PBR. However, this does not include the estimated average annual mortality in the North Atlantic bottom trawl fishery, which is under review.

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