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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 30ºN (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 Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data).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 some 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*. 2006).

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 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; Schroeder 2000; 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 around a dozen pups or less by 2002 (Baird 2001; Bowen *et al.* 2003). A decline in the number of juveniles and adults did not occur

immediately, but a decline was observed in these age classes as a result of the reduced number of pups moving into the older age classes (Bowen *et al*. 2003). Possible reasons for this decline may be increased use of the island by gray seals and increased predation by sharks (Stobo and Lucas 2000; Bowen *et al.* 2003). Helicopter surveys have also been flown to count hauled-out animals along the coast and around small islands in parts of the Gulf of St. Lawrence and the St Lawrence estuary. In the estuary, surveys were flown during June 1995, 1996, and 1997, and in August during 1994, 1995, 1996 and 1997 and in different parts of the Gulf during June 1996 and 2001 (Robillard *et al*. 2005). Changes in counts over time in sectors that were flown under similar conditions were examined at nine sites that were surveyed in June and in August. Although all slopes were positive, only one was significant, indicating numbers are likely stable or increasing slowly. Overall, the June surveys resulted in an average of 469 (SD=60, N=3) hauled-out animals, which is lower than a count of 621 (SD=41, N=3) hauled-out animals flown under similar conditions in August. Aerial surveys in the Gulf of St. Lawrence resulted in counts of 467 animals in 1996 and 423 animals in 2001 for a different area (Robillard *et al.* 2005).

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 0.5, the value for stocks of unknown status. PBR for U.S. waters is 2,746.

ANNUAL HUMAN-CAUSED MORTALITY

For the period 2001-2005 the total human caused mortality and serious injury to harbor seals is estimated to be 893 per year. The average is derived from three components: 1) 882 (CV=0.16); Table 2) from the 2001-2005 observed fishery; 2) 10 from average 2001-2005 non-fishery related, human interaction stranding mortalities (NMFS unpublished data); and 3) 1 incidental scientific take in 2001 (Waring 2006).

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 542 harbor seal mortalities observed in the Northeast sink gillnet fishery between 1990 and 2005, 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). Estimated annual mortalities (CV in parentheses) from this fishery -were 332 (0.33) in 1998, 1,446 (0.34) in 1999, 917 (0.43) in 2000, 1,471 (0.38) in 2001, 787 (0.32) in 2002, 542 (0.28) in 2003, 792 (0.34) in 2004, and 719 (0.20) in 2005 (Table 2). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). There were 8, 2, 2, 9, and 14 unidentified seals observed during 2001-2005, 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 2001-2005 was 862 harbor seals (CV=0.16) (Table 2).

Mid-Atlantic Gillnet

No harbor seals were taken in observed trips during 1993-1997, or 1999-2003. Two harbor seals were observed taken in 1998, one in 2004, and two in 2005. 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), 15 (0.86) in 2004, and 63 (0.67) in 2005. 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. Average annual estimated fishery-related mortality attributable to this fishery during 2001-2005 was 20 (CV = 0.57) harbor seals (Table 2).

Northeast Bottom Trawl

Two harbor seal mortalities were observed between 2001 and 2005, one in 2002 and one in 2005 (Table 2). The estimated annual fishery-related mortality and serious injury attributable to this fishery has not been generated.

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 in 2004 and 4 in 2005. In addition, 5 seals of unknown species were captured and released alive in 2004 and 2 in 2005.

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; Cairns *et al.* 2000). 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 Sink Gillnet [c]	01-05	unk [d]	Obs. Data, Weighout, Logbooks	.04, .02, .03, .06, .07	32, 12, 21, 45, 70	1471, 787, 542, 792, 719	.38, .32, .28, .34, .20	862 (0.16)
Mid-Atlantic Gillnet	01-05	unk [d]	Obs. Data, Weighout	.02, .01, .01, .02, .03	0, unk [e], 0, 1, 2	0, unk [e], 0, 15, 63	0, unk [e], 0, .86, .67	20 (0.57) [e]
Northeast Bottom Trawl	01-05	unk [d]	Obs. Data, Weighout	.01, .03, .04 .05, tbd	0, 1, 0, 0, 1	0, unk [f], 0, 0, unk	0, unk [f], 0, 0, unk	unk [f]
TOTAL								882 (0.16)

[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 coverages for the Northeast sink gillnet fishery and the mid-Atlantic gillnet fisheries are ratios based on tons of fish landed and coverages for the northease bottom trawl are ratios based on trips.

[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 2001 - 2005, respectively, 8, 10, 3, 0, 8, 3 takes were observed in nets with pingers. In 2001 – 2005, respectively, 22, 9, 21, 37, 67 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 (2001, and 2003- 2005) estimated mortality was applied as the best representative estimate.

[f] Analysis of bycatch mortality attributed to the Northeast bottom trawl fishery for the years 2001-2005 has not been generated.

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 2001-2005, 1,717 harbor seal stranding mortalities were reported in all states between Maine and North Carolina (Table 3; NMFS unpublished data). Sixty-eight (4.0%) of

the seals stranded during this five year period showed signs of human interaction (9 in 2001, 18 in 2002, 2 in 2003, 15 in 2004, and 24 in 2005), with 17 having some sign of fishery interaction (1 in 2001, 9 in 2002, 0 in 2003, 3 in 2004, and 4 in 2005). An Unusual Mortality Event (UME) was declared for harbor seals in northern Gulf of Maine waters in 2003 and continued into 2004. No consistent cause of death could be determined. The UME was declared over in spring 2005 (MMC 2006). NMFS declared another UME in the Gulf of Maine in autumn 2006 based on infectious disease.

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. The decline in the Sable Island population appears to result from a combination of shark-inflicted mortality, on both pups and adult females and inter-specific competition with the much more abundant gray seal for food resources (Stobo and Lucas 2000; Bowen *et al*. 2003).

Table 3. Harbor seal (*Phoca vitulina*) stranding mortalities along the U.S. Atlantic coast (2001-2005)[a].

State	2001	2002	2003[b]	2004[b]	2005	Total
ME	85	149	212	358	148	952
NH	5	2	15	21	31	74
MA	57	90	98	146	112	503
RI	5	4	12	11	4	36
CT	4		1	3	2	10
NY	12	8	10	14	23	67
NJ	4	6	15	5	4	34
DE			2		4	6
MD			1	1	3	5
VA	2	1	2	1	3	9
NC	3	2	8		7	20
FL			1			1
Total	177	262	377	560	341	1717
Unspecified seals (all states)	37	35	27	33	59	191

a. Some of the data reported in this table differ from that reported in previous years. We have reviewed the records and made an effort to standardize reporting. Live releases and rehabbed animals have been eliminated

b. Unusual Mortality Event (UME) declared for harbor seals in northern Gulf of Maine waters during 2003-2004.

STATUS OF STOCK

The status of the western North Atlantic harbor seal stock, relative to OSP, in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. 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.

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