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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 USA and Canadian coasts represent one population (Temte *et al*. 1991). In USA 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; 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 Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data).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 (NMFS unpub. data), 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).

POPULATION SIZE

Since passage of the MMPA in 1972, the observed count of seals along the New England coast has increased nearly nine-fold. Six coast-wide aerial surveys along the Maine coast have been conducted in May/June during pupping. Annual counts, with number of pups in parentheses, between 1981 to 2001 were 10,540 (676) in 1981, 9,331 (1,198) in 1982, 12,940 (1,713) in 1986, 28,810 (4,250) in 1993, 30,990 (5,359) in 1997, and 99,340 (23,723) in 2001 (Table1; Gilbert and Stein 1981; Gilbert and Wynne 1983, 1984; Kenney 1994; Gilbert and Guldager 1998; J. Gilbert, pers. comm.). As recommended in the GAMMS Workshop Report (Wade and Anglis 1997), estimates older than eight years and are deemed unreliable, therefore should not be used for PBR determinations. 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. A coast-wide survey, which included replicate surveys and radio tagged seals to obtain a correction factor for animals not hauled out, was conducted in May/June 2001. The 2001observed count of 38,011 was 22.7% 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 from 600 in 1989 to 30 in 1997 (Baird 2001).

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}[1]	CV
May/June 1997	Maine coast	30,990 (5,359)	None reported
May/June 2001	Maine coast	99,340 (21,732)[2]	CV = .097

[1]Pup counts are in brackets
[2] Uncorrected count of 38,011 (8,814)

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 (CV = .097) based on corrected total counts along the Maine coast in 2001.

Current Population Trend

The average increase in uncorrected counts over the 1981-2001 survey period (e.g., 1981, 1982, 1986, 1993, 1997, and 2001) has been . 6.6 % (J. Gilbert, pers. comm.). The 1981 survey was in early June and the 1986 survey was in mid- to late June; therefore, peak pupping period was likely missed in both years. 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 habitat protection of important haulout sites (e.g., National Park Service and National Wildlife Refuge lands).

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 was approximately 6.6 % (J. Gilbert, pers. comm.). 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 USA waters is 5,493.

ANNUAL HUMAN-CAUSED MORTALITY

For the period 1997-2001, the total estimated human caused mortality and serious injury to harbor seals is estimated to be 972 per year. The average is derived from two components: 1) 955 (CV= 0.18; Table 2) from the 1997-2001 observed fishery; and 2) 17 from average 1997-2001 stranding mortalities resulting from boat strikes, power plant entrainments, shooting, and other sources.

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

USA

Historical: 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 is no data to support this.

Current: Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Fisheries Observer Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Northeast Multispecies Sink Gillnet:

In 1993, there were approximately 349 full and part-time vessels in the Northeast multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. In 1998, there were approximately 301 vessels in this fishery (NMFS unpublished data). Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, 4%, 6%, 5%, 6%, 6%, and 4% for 1990 to 2001, respectively. The fishery has been observed in the Gulf of Maine and in southern New England (Williams 1999). There were 394 harbor seal mortalities observed in the Northeast multispecies sink gillnet fishery between 1990 and 2001, 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 multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990- 2001 were 602 in 1990 (0.68), 231 in 1991 (0.22), 373 in 1992 (0.23), 698 in 1993 (0.19), 1,330 in 1994 (0.25), 1,179 in 1995 (0.21), 911 in 1996 (0.27), 598 in 1997 (0.26), 332 in 1998 (0.33), 1446 in 1999 (0.34), 917 (0.43) in 2000, and 1471 (.38) in 2001. The 1994 and 1995 bycatches, respectively, include 14 and 179 animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of bycatch of harbor seals, gray seals, harp seals, and hooded seals. 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. There were 0, 1, 5, and 8 unidentified seals observed during 1998 through 2001, respectively. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1997-2001 was 953 harbor seals (CV= 0.18). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred in Massachusetts Bay, south of Cape Ann and west of Stellwagen Bank during January-March. Bycatch locations became more dispersed during April-June from Casco Bay to Cape Ann, along the 30 fathom contour out to Jeffreys Ledge, with one take location near Cultivator Shoal and one off southern New England near Block Island. Incidental takes occurred from Frenchman's Bay to Massachusetts Bay during July-September. In inshore waters, the takes were aggregated while offshore takes were more dispersed. Incidental takes were confined from Cape Elizabeth out to Jeffreys Ledge and south to Nantucket Sound during October-December.

Mid-Atlantic Coastal Gillnet

Observer coverage of the USA Atlantic coastal gillnet fishery was initiated by the NEFSC Fisheries Observer program in July, 1993; and from July to December 1993, 20 trips were observed. During 1994 and 1995, 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. Observer coverage, expressed as percent of tons of fish landed, was 5%, 4%, 3%, 5%, 2%, 2%, and 2% for 1995, 1996, 1997, 1998, 1999, 2000, and 2001, respectively (Table 2).

No harbor seals were taken in observed trips during 1993-1997, and 1999-2001. Two harbor seals were observed taken in 1998 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC 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 1999-2001 and 11 in 1998 (0.77). Average annual estimated fishery-related mortality attributable to this fishery during 1997-2001 was 2 harbor seals (CV=0.77).

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	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast [3] Multispecies Sink Gillnet	97-01	301	Obs. Data Weighout, Logbooks	.06, .05, .06, .06, .04	48, 15, 49, 26, 32	598, 332, 1446, 917, 1471	.26, .33, .34, .43, .38	953 (0.18)
mid-Atlantic Coastal Sink Gillnet	97-01	Unk[4]	Obs. Data Weighout	.03, .05, .02, .02, .02	0, 2, 0, 0, 0	0, 11, 0, 0, 0	0, .77, 0, 0, 0	2 (.77)
TOTAL								955 (0.18)

[1] Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) 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 multispecies sink gillnet fishery.

[2] The effort for the Northeast multispecies sink gillnet fishery is measured in trips. Observer coverage of the mid-Atlantic coastal gillnet fishery is measured in tons of fish landed.

[3] 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.

[4] Number of vessels is not known.

Other Mortality

Harbor seals were bounty hunted in New England waters until the mid-1960's, which may have caused the demise of this stock in USA waters (Katona *et al*. 1993).

Annually, small numbers of harbor seals regularly strand throughout their migratory range. Most reported strandings, however, occur during the winter period in southern New England and mid-Atlantic regions (NMFS unpublished data). Sources of mortality include human interactions (boat strikes and fishing gear, power plant intake (12-20 per year; NMFS unpublished data), oil, shooting , storms, abandonment by the mother, and disease (Katona *et al*. 1993; Jacobs and Terhune 2000; NMFS unpublished data). Interactions with Maine salmon aquaculture operations appears to be increasing, although the magnitude of interactions and seal mortalities has not been quantified (Anon 1996). Aquaculture operations in eastern Canada are licenced to shoot nuisance seals, but issuance of personal "Fishing Licence" to hunt seals is closed for harbour seals (Baird 2001). In 1980, more than 350 seals were found dead in the Cape Cod area from an influenza outbreak (Geraci *et al*. 1981).

Reported harbor seal strandings from1997 to 2001 were:153 in 1997, 256 in 1998, 150 in 1999, 219 in 2000, and 246 in 2001. Strandings were reported in all states between Maine and North Carolina, and in 1997 one each was reported in Georgia and Florida. Of 1024 strandings, Maine (446), Massachusetts (258), New York (104) and New Jersey (61) accounted for most of the strandings, reflecting both long coastlines and habitat use. Eighty-six (8.4%) of the stranded animals during this five year period showed signs of human interactions: fishery (24), vessel strike (8), power plant (22), and other (32). Further, many live strandings are euthanized due to condition of the animals. Some

sick and injured seals are transported to rehabilitation facilities, and some human harassed (e.g., attempted feeding, petting , etc) seals are relocated.

Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other 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.

STATUS OF STOCK

The status of harbor seals, relative to OSP, in the US Atlantic EEZ is unknown, but the population is increasing. The species is not listed as threatened or endangered under the Endangered Species Act. Gilbert and Guldager (1998) estimated a 4.4% annual rate of increase of this stock in Maine coastal waters based on 1981, 1982, 1986, 1993, 1997 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.

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