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HARP SEAL (*Pagophilus groenlandicus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The harp seal occurs throughout much of the North Atlantic and Arctic Oceans (Ronald and Healey 1981; Lavigne and Kovacs 1988); however, in recent years, numbers of sightings and strandings have been increasing off the east coast of the United States from Maine to New Jersey (Katona *et al.* 1993; Stevick and Fernald 1998; B. Rubinstein, pers. comm., New England Aquarium; McAlpine 1999; Lacoste and Stenson 2000). These extralimital appearances usually occur in January-May (Harris *et al.* 2002), when the western North Atlantic stock of harp seals is at its most southern point of migration. Concomitantly, a southward shift in winter distribution off Newfoundland was observed during the mid-1990s, which was attributed to abnormal environmental conditions (Lacoste and Stenson 2000). The world's harp seal population is divided into three separate stocks, each identified with a specific breeding site (Bonner 1990; Lavigne and Kovacs 1988). The largest stock is located in the western North Atlantic off eastern Canada and is divided into two breeding herds which breed on the pack ice. The Front herd breeds off the coast of Newfoundland and Labrador, and the Gulf herd breeds near the Magdalen Islands in the middle of the Gulf of St. Lawrence (Sergeant 1965; Lavigne and Kovacs 1988). The second stock breeds in the White Sea off the coast of the Soviet Union, and the third stock breeds on the West Ice off eastern Greenland (Lavigne and Kovacs 1988). Harp seals are highly migratory (Sergeant 1965; Stenson and Sjare 1997). Breeding occurs at different times for each stock between mid-February and April. Adults then assemble north of their whelping patches to undergo the annual molt. The migration then continues north to Arctic summer feeding grounds. In late September, after a summer of feeding, nearly all adults and some of the immature animals migrate southward along the Labrador coast, usually reaching the entrance to the Gulf of St. Lawrence by early winter. There they split into two groups, one moving into the Gulf and the other remaining off the coast of Newfoundland.

The extreme southern limit of the harp seal's habitat extends into the U.S. Atlantic Exclusive Economic Zone (EEZ) during winter and spring. Support for the increase in numbers and geographic distribution of harp seals in New England to Mid-Atlantic waters is based primarily on strandings, and secondarily on fishery bycatch (McAlpine and Walker 1990; Rubinstein 1994).

POPULATION SIZE

The total population size of harp seals is unknown; however, three seasonal abundance estimates are available which use a variety of methods including aerial surveys and mark-recapture (Table 1). Generally, these methods include surveying the whelping concentrations and modeling pup production. Harp seal pup production in the 1950's was estimated at 645,000 decreasing to 225,000 by 1970 (Sergeant 1975). Estimates began to increase at that time and have continued to rise, reaching 478,000 in 1979 (Bowen and Sergeant 1983; Bowen and Sergeant 1985), 577,900 in 1990 (Stenson *et al.* 1993), and 998,000 in 1999 (Stenson *et al.* 2000).

Roff and Bowen (1983) developed an estimation model to provide a more precise estimate of total abundance. This technique incorporates recent pregnancy rates and estimates of age-specific hunting mortality (CAFSAC 1992). Shelton *et al.* (1992) applied a harp seal estimation model to the 1990 pup production and obtained an estimate of 3.1 million (range 2.7-3.5 million; Stenson 1993). Using a revised population model, 1994 pup count data, and two assumptions regarding pup mortality rates, Shelton *et al.* (1996) estimated pup production and total population size for the period 1955-1994. The 1994 total population estimate was 4.8 million (95% CI= 4.1-5.5 million) harp seals (Warren *et al.* 1997). The 1999 population estimate was 5.2 million (95% CI=4.0-6.4 million) harp seals (Healey and Stenson 2000) (Table 1).

Table 1. Summary of abundance estimates (pups and total) for western North Atlantic harp seals. Year and area covered during each abundance survey, resulting abundance estimate (N_{best}) and coefficient of variation

Month/Year	Area	N_{best}	CV
1999	Eastern Atlantic Canada - Labrador	998,000 pups	±200,000 (95% CI)
1999	Eastern Atlantic Canada - Labrador	5.2 million	±1,200,000 (95% CI)

Minimum population estimate

Present data are insufficient to calculate the minimum population estimate for U.S. waters. It is estimated there are at least 5.2 million (±1.2 million) harp seals in Canada (Healey and Stenson 2000).

Current population trend

The population appears to be increasing in U.S. waters, judging from the increased number of stranded harp seals, but the magnitude of the suspected increase is unknown. In Canada, since 1996 the population has been stable (5.2 million; ±1.2 million) due to large harvests of young animals in recent years (Healey and Stenson 2000).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. The best data are based on Canadian studies. Recent studies indicate that pup production has increased (Stenson *et al.* 2002, Stenson *et al.* 2003), but the rate of population increase cannot be quantified at this time (Stenson *et al.* 1996). The mean age of sexual maturity was 5.8 yrs in the mid-1950's, declining to 4.6 yrs in the early 1980's and then increasing to 5.6 yrs in the mid-1990's (Sjare *et al.* 1996; Sjare and Stenson 2000).

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, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size in U.S. waters is unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) was set at 1.0 because it was believed that harp seals are within OSP. PBR for the western North Atlantic harp seal in U.S. waters is unknown. Applying the formula to the minimum population estimate for Canadian waters results in a "PBR" of 312,000 harp seals. However, Johnston *et al.* (2000) suggests that catch statistics from the Canadian hunt are negatively biased due to under reporting; therefore, an F_R of 0.5 may be appropriate. Using the lower F_R results in a "PBR" of 156,000 harp seals. The Canadian model predicts replacement yields between 522,000 and 541,000 (Healey and Stenson 2000).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 1999-2003, the total estimated annual human caused mortality and serious injury to harp seals was 453,962. Estimated annual human caused mortality in US waters is 41, derived from two components: 1) 36 harp seals (CV=0.53) from the observed U.S. fisheries (Table 2), and 2) 4.6 from average 1999-2003 stranding mortalities resulting from human interactions (NMFS unpublished data). The remaining mortality is derived from five components: 1) 232,915 from to 1999-2003 average commercial catches of northwest Atlantic harp seals by Canada (244,552 in 1999, 91,602 in 2000, 226,493 in 2001, 312,367 in 2002, and 289,512 in 2003) (Hammill and Stenson 2003, DFO 2003, Stenson unpublished data); 2) 83,010 from 1999-2002 (2003 unavailable) average Greenland catch (97,583 in 1999, 101,941 in 2000, 81,390 in 2001, and 51,124 in 2002) (Anonymous 2003, Stenson unpublished data), 3) 4,881 average catches in the Canadian Arctic (4,881 in each year) (Hammill and Stenson, 2003), and 4) 18,566 from 1999-2002 (2003 unavailable) average bycatches in the Newfoundland lumpfish fishery (18,443 in 1999, 18,607 in 2000, 18,607 in 2001, and 18,607 in 2002) (Stenson unpublished data), and 5) 119,430 from 1999-2002 (2003 unavailable) average struck and lost animals (animals that are killed but not recovered) (21,748 in 1999, 117,864 in 2000, 109,313 in 2001 and 128,794 in 2002) (Stenson unpublished data). The struck and lost component can be further broken down into struck and lost from the commercial harvest (20,902 average from 1999 to 2002 (2003 unavailable): 19,284 in 1999, 11,043 in 2000, 23,042 in 2001, and 30,275 in 2002), and struck and lost from the Canadian Arctic and Greenland harvests (87,890 average from 1999 to 2002; 2003 unavailable): 102,464 in 1999, 106,822 in 2000, 86,271 in 2001, and 56,005 in 2002) (Stenson unpublished data). Struck and lost is calculated for the commercial harvest assuming that the rate is 5% for young of the year, and 50% for animals one year of age and older (DFO 2001, Stenson unpublished data). The Canadian Arctic and Greenland struck and lost rate is calculated assuming the rate is 50% for all age classes (DFO 2001; Stenson unpublished data).

Fishery Information

U.S.

Detailed fishery information is reported in the Appendix III.

Northeast Sink Gillnet:

There were 122 harp seal mortalities observed in the Northeast sink gillnet fishery between 1990 and 2002. Annual estimates of harp 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: 81 in 1999 (0.78), 24 in 2000 (1.57), 26 in 2001 (1.04), and 0 during 2002-2003 (Table 2) There were 1, 5, 8, 2, and 2 unidentified seals observed during 1999 through 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 26 harp seals (CV=0.60). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred principally in winter (January-May) and was mainly in waters between Cape Ann and New Hampshire. One observed winter mortality was in waters south of Cape Cod.

Mid-Atlantic Coastal Gillnet:

No harp seals were taken in observed trips during 1993-1997, and 1999-2003. One harp seal was observed taken in 1998. Observed effort from 1993-2003 was scattered between New York 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, 17 in 1998 (1.02) and 0 in 1999-2003 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 1999-2003 was zero harp seals.

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 1991-2000, one mortality was observed in 2001, and zero mortalities were observed in 2002. 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 (CV in parentheses) was 0 between 1991-2000, 49 (CV=1.10) in 2001, and 0 between 2002-2003. Average annual estimated fishery-related mortality attributable to this fishery in between 1999-2003 was 10 harp seals (CV=1.10) (Table 2). These estimates should be viewed with caution due to the extremely low (<1%) observer coverage.

CANADA

An unknown number of harp seals have been taken in Newfoundland and Labrador groundfish gillnets (Read 1994). Harp seals are being taken in Canadian lumpfish and groundfish gillnets and trawls, but estimates of total removals have not been calculated to date. A recent analysis of bycatch in the Newfoundland lumpfish fishery indicates that fewer than 10,000 seals were taken annually from the start of the fishery in 1968 until 1984 (Walsh *et al.* 2000). Between 1984 and 1995, annual bycatches were more variable, ranging between 3,000 and 36,000 animals. Since 1996, bycatches have varied between 16,000 and 23,000 seals (DFO 2000), averaging 17,000 annually (Walsh *et al.* 2000, DFO 2001).

In 1996, observers recorded 4 harp seals (1 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 harp seal (*Phoca groenlandica*) 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[c]	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast Sink Gillnet	99-03	301	Obs. Data Weighout, Logbooks	.06, .06, .04, .02, .03	4, 3, 1, 0,0	81, 24, 26, 0, 0	.78, 1.57, 1.04, 0, 0	26 (0.60)
Mid Atlantic Coastal Sink Gillnet	99-03	unk[d]	Obs. Data Weighout	.02, .02, .02, .01, .01	0, 0, 0, 0, 0	0, 0, 0, unk[e], 0	0, 0, 0, unk[e], 0	0 (0)
North Atlantic Bottom Trawl	99-03	tbd	Obs. Data Weighout	.003, .004, .004, .021, tbd	0, 0, 1, 0, 0	0, 0 49, 0, 0	0, 0, 1.10, 0, 0	10 (1.10)
TOTAL								36 (0.53)

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 observer coverage for the Northeast sink gillnet fishery is measured in trips. Observer coverage for the Mid-Atlantic coastal sink gillnet fishery is measured in tons of fish landed. North Atlantic bottom trawl fishery coverage is measured in trips.

c In the Northeast sink gillnet fishery, 31 and 0 harp seals were taken on pingered trips during 1997 and 1998, respectively. During 1997, 1998, 1999, 2000 and 2001, there were 31, 4, 2, 2 and 1 harp seals observed on "mammal trips", respectively. See Bisack (1997) for "trip" type definitions. Between 1999 and 2001 respectively, 2, 1 and 0 harp seals were observed on "fish trips" and 3, 2 and 1 were observed taken from pingered nets.

d Number of vessels is not known.

e Sixty-five percent of sampling by the NEFSC fisheries observer program was concentrated in one area and not distributed proportionally across the fishery. Therefore, observed mortality is considered unknown in 2002. The previous five year average (97-01) estimated mortality was applied.

Other Mortality

Canada: Harp seals have been commercially hunted since the mid-1800's in the Canadian Atlantic (Stenson 1993). The total allowable catch (TAC) of harp seals in Canada has ranged from a low of 186,000 to a high of 350,000 between 1971 and 2003. Catches ranged from a low of 19,000 to a high of 312,367 over the same period. Low catches were reported between the years of 1983 and 1995 due to a limited market for seal products (Anonymous 2003). The Atlantic Seal Hunt 2003-2005 Management Plan (Anonymous 2003) allows for a three-year TAC of 975,000, with an annual TAC of up to 350,00 any one or two of the years, provided that the combined TAC over three years does not exceed 975,000.

Harp seals are also hunted in the Canadian Arctic and in Greenland (DFO 2000). There are no recent statistics for the Canadian Arctic, but Hammill and Stenson (2003) estimate the Arctic catch to be 4,811 annually. Prior to 1980, Greenland catches were fewer than 20,000 annually, but in recent years have dramatically increased to around 100,000 (DFO 2000). These numbers do not account for animals that are killed but not landed (struck and lost) (Lavigne 1999). A recent analysis of the struck and lost rates suggests that the rate for young seals (majority of Canadian take) is less than 5%, while losses of older seals, and seals taken in the Canadian Arctic and Greenland, are higher (approximately 50%) (DFO 2001). The Healy and Stenson (2000) model for determining harp seal population incorporates struck-and-lost and bycaught seals.

U.S. From 1988 to 1993 strandings each year were under 50, approaching 100 animals in 1994, and exceeding 100 animals in 1995-1996 (Rubinstein 1994; B. Rubinstein, New England Aquarium, pers. comm.). From 1999 to 2003, 1,146 strandings were recorded (116 in 1999, 145 in 2000, 495 in 2001, 188 in 2002, and 97 in 2003) in all states between Maine and North Carolina (NMFS unpublished data). Factors contributing to a dramatic increase in strandings in 2001 are unknown (Harris *et al.* 2002). Twenty-three (2.0%) of the stranded animals during this five year period showed signs of human interaction as a direct cause of mortality. Mortalities caused by human interaction include boat strikes, fishing gear interactions, power plant entrainment, oil spills, harassment, and shooting.

The total number of harp seal strandings in 2003 was 97, of which 7 were healthy and did not require rehabilitation. Seventeen animals were rehabilitated and released. The remaining animals were either found dead or died in rehabilitation.

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

State	2002	2003	Total
Maine	35	21	56
New Hampshire	1	1	2
Massachusetts	67	31	98
Rhode Island	10	6	16
Connecticut	12	1	13
New York	48	24	72
New Jersey	13	9	22
Delaware	0	1	1
Maryland	0	1	1
Virginia	1	0	1
North Carolina	1	2	3

STATUS OF STOCK

The status of the harp seal stock, relative to OSP, in the U.S. Atlantic EEZ is unknown, but the population appears not to be increasing in Canadian waters. The species is not listed as threatened or endangered under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is believed to be very low relative to the population size in Canadian waters and can be considered insignificant and approaching zero mortality and serious injury rate. The level of human-caused mortality and serious injury in the U.S. Atlantic EEZ is believed to be very low relative to the total stock size; therefore, this is not a strategic stock.

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