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HARP SEAL (*Phoca groenlandica*): 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; Anon 1998). 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 USA 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 1950s 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 . 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_{min}) and coefficient of variation (CV).

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 USA 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 USA 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, 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-1990s (Sjare *et al.* 1996; Sjare and Stenson 2000b).

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 USA 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 USA 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.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 1997-2001, the total estimated human caused mortality and serious injury to harp seals was 287,949. This is derived from four components: 1) 268,337 from 1997 to 2001 (1997=333,873; 1998=365,115; 1999=324,606; 2000=91,602 and 2001= 226,493) average catches of Northwest Atlantic harp seals by Canada and Greenland; 2) 16,000 - 23,000 (annually) from average bycatches in the Newfoundland lumpfish fishery; 3) 109 harp seals CV=0.31 from the observed USA fisheries (Table 2), and 4) 3 from average 1997 to 2001 stranding mortalities showing signs of human interaction.

Fishery Information

USA

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.

Recent bycatch has been observed by NMFS Sea Samplers in the Northeast multispecies sink gillnet fisheries, but no mortalities have been documented in the mid-Atlantic coastal gillnet, Atlantic drift gillnet, pelagic pair trawl or pelagic longline fisheries.

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 310 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. There were 122 harp seal mortalities observed in the Northeast multispecies sink gillnet fishery between 1990 and 2001. Annual estimates of harp 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 0 during 1990-1993, 861 in 1994 (0.58), 694 in 1995 (0.27), 89 in 1996 (0.55), 269 in 1997 (0.50), 78 in 1998 (0.48), 81 in 1999 (0.78), 24 in 2000 (1.57) and 26 in 2001 (1.04). The 1994 and 1995 bycatches include 16 and 153 animals, respectively, 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 96 harp seals (CV=0.33). 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:

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 harp seals were taken in observed trips during 1993-1997, and 1999-2001. One harp seal was observed taken in 1998 (Table 2). Observed effort 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 1999-2001. Average annual estimated fishery-related mortality attributable to this fishery during 1997-2001 was 3.0 harp seals (CV=1.02).

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. An average of 970 vessels (full and part time) participated annually in the fishery during 1991-1995. The fishery is active in all seasons in New England waters. No mortalities were observed between 1991-2000 and one mortality was observed in 2001. Observer coverage, expressed as number of trips, was < 1% from 1997 to 2001 (Table 2). The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 0 between 1991- 2000, and 49 (CV=1.10) in 2001. Average annual estimated fishery-related mortality attributable to this fishery in 2001 was 10 harp seals (CV=1.10) (Table 2). However, 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 (Read. 1994). 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 have been more variable, ranging between 3,000 and 36,000 animals. Since 1996, bycatches have varied between 16,000 and 23,000 seals annually (DFO 2000).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

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 [1]	Observer Coverage [2]	Observed Mortality[3]	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northeast Multispecies Sink Gillnet	97-01	301	Obs. Data Weighout, Logbooks	.06, .05, .06, .06, .04	40, 4, 4, 3, 1	269, 78, 81, 24, 26	.50, .48, .78, 1.57, 1.04	96 (.33)
Mid Atlantic Coastal Sink Gillnet	97-01	Unk[4]	Obs. Data Weighout	.03, .05, .02, .02, .02	0, 1, 0, 0, 0	0,17, 0, 0, 0	0, 1.02, 0, 0, 0	3 (1.02)
North Atlantic Bottom Trawl	97-01	970	Obs. Data Weighout	.002, .001, .003, .003, .004	0, 0, 0, 0, 1	0, 0, 0, 0, 0, 49	0, 0, 0, 0, 1.10	10 (1.10)
TOTAL								109 (.31)

[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 observer coverage for the Northeast multispecies 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.

[3] In the New England 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, 2, 1, and 0 harp seals, respectively, were observed on “fish trips” and 3, 2, and 1 were observed taken from pingered nets.

[4] Number of vessels is not known.

Other Mortality

Harp seals have been commercially hunted since the mid-1800's in the Canadian Atlantic (Stenson 1993). A total allowable catch (TAC) of 200,000 harp seals was set for the large vessel hunt in 1971. The TAC varied until 1982 when it was set at 186,000 seals and remained at this level through 1995 (Stenson 1993; Anon 1998). The TAC was increased to 250,000 and 275,000, respectively, in 1996 and 1997 (Anon 1998). The 1997 TAC has remained in effect through 2001 (Anon 2001a). In 2001, the Canadian Minister of Fisheries and Oceans established a panel of eminent persons to provide advice on a long-term strategy for the management of seal populations (Anon 2001). Catches ranged from 124,000 to 231,000 from 1971 to 1982, declined to a range of 19,000 to 94,000 between 1983 and 1995, and increased dramatically to 243,000 in 1996 and 282,000 in 1998 (Stenson 1993; Anon 1998; Anon 2001). Catches declined to 92,000 in 2000 (Anon 2001b). Harp seals are also hunted in the Canadian Arctic and in Greenland (DFO 2000). There are no recent statistics for the Canadian Arctic, but during the late 1970's annual catches ranged between 1,200 and 6,500 animals. Prior to 1980, Greenland catches were fewer than 20,000 annually, but in recent years have dramatically increased to around 100,000 (DFO 2000). The commercial catches do not account for subsistence takes and 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 are higher (approximately 50%) (DFO 2000; Sjare and Stenson 2000a).

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.). In addition, in 1996 there was a stranding in North Carolina. From 1997 to 2001, 980 strandings were recorded, of which 50% (495) were in 2001. Fifty-two percent (n=258) of the 2001 strandings were carcasses, and the remaining 48% were live strandings. Strandings were recorded from Maine (166/17%) to North Carolina (1), and the highest numbers were in Massachusetts (339/35%) and New York (277/28%). Many were live strandings and some were euthanized due to the animal’s condition. Some sick and injured seals were transported to rehabilitation facilities, and some

subsequently died. Few harp seals showed signs of human interactions and, except for 4 shot animals, 8 fishery interactions, 1 mutilated animal, 1 boat strike, and 1 ingested plastic, the interactions were classified as other (e.g., no signs of human interaction) . Changes in environmental conditions, collapse of fish stocks, and changes in the distribution of prey off Atlantic Canada have been suggested as causes of the southward and extralimital seasonal shift in harp seal distribution since the mid 1990's (McAlpine *et al*. 1999; Lacoste and Stenson 2000). Factors contributing to a dramatic increase in strandings in 2001 are unknown (Harris *et al*. 2002), but may indicate a possible shift in distribution or expansion southward into USA waters.

STATUS OF STOCK

The status of the harp seal stock, relative to OSP, in the US 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 USA 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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