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). The world's harp seal population is divided into three separate stocks, each identified with a specific pupping site on the pack ice (Lavigne and Kovacs 1988; Bonner 1990). The largest stock is located off eastern Canada and is divided into two breeding herds (Figure 1). 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 on the West Ice off eastern Greenland (Lavigne and Kovacs 1988), and the third stock breeds on the ice in the White Sea off the coast of Russia. The Front/Gulf stock is equivalent to the western North Atlantic stock. Perry *et al.* (2000) found no significant genetic differentiation between the two Northwest Atlantic whelping areas, though the authors pointed out some uncertainty surrounding that finding due to small sample sizes.

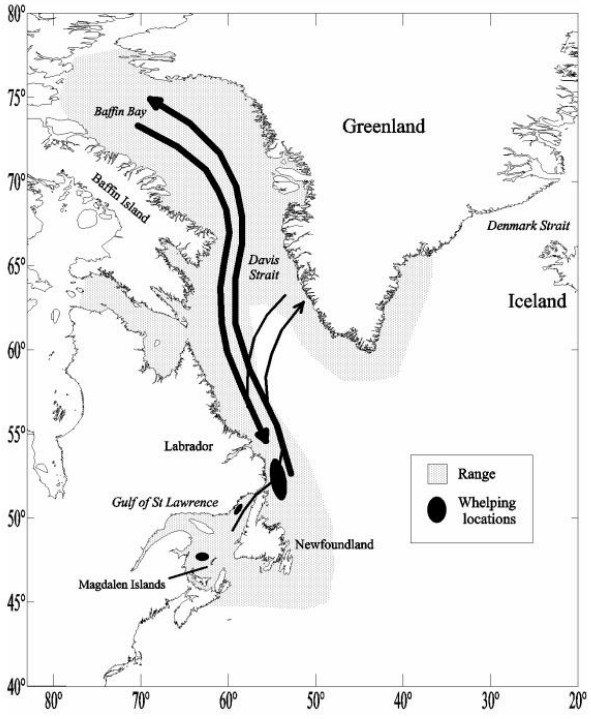

Figure 1. Current Status of Northwest Atlantic Harp Seals, Pagophilus groenlandicus

Harp seals are highly migratory (Sergeant 1965; Stenson and Sjare 1997). Breeding occurs at different times for each stock between late-February and April. Adults then assemble on suitable pack ice 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 of the western North Atlantic stock 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 southern limit of the harp seal's habitat extends into the U.S. Atlantic Exclusive Economic Zone (EEZ) during winter and spring.

Since the early 1990s, 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; Rubinstein 1994; Stevick and Fernald 1998; McAlpine 1999; Lacoste and Stenson 2000; Soulen *et al.* 2013). These 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).

POPULATION SIZE

The size of the western North Atlantic stock of harp seals is estimated by fitting age-structured population models to estimates of total pup production in Canada. Since 1990, aerial surveys of the whelping patches have been flown to determine pup production (Stenson *et al.* 2020a). These estimates are then fit to population models taking into account

reproductive rates, ice-related mortality, and anthropogenic removals. Total estimated pup production from the last pupping survey which occurred in March 2017 was 746,500 (95% CI: 570,300–922,700; DFO 2020). There was some uncertainty in results of the survey due to poor ice conditions in the southern Gulf of St Lawrence, and changes in the timing of pupping due to the movement of animals among whelping patches (Stenson *et al.* 2020a). After the 2017 survey the population model was updated to account for the effects of continued poor ice conditions and other environmental changes acting on juvenile mortality and reproductive rates. In 2019, estimated pup production from the model was 1.4 million (95% CI: 1.2–1.5 million), and the total population size was estimated to be 7.6 million (95% CI: 6.6–8.8 million; DFO 2020). The estimated population size in 2019 was slightly higher than in 2012, when the last pupping survey was conducted (Table 1). Sources of uncertainty in the population models include annual reproductive rate data, the level and age structure of various sources of removals, changes in mortality due to varying ice conditions and predicted ice changes in the future and its impact on prey availability (DFO 2020).

Table 1. Summary of abundance estimates for western North Atlantic harp seals in Canadian waters. Year and area covered during each abundance survey, resulting abundance estimate (N_{est}) and confidence interval (CI).

Year	Area	N_{est}	CI
2014 [a]	Front and Gulf	7.4 million	(95% CI: 6.1–8.7 million)
2019 [b]	Front and Gulf	7.6 million	(95% CI: 6.5 – 8.8 million)

a. The 2014 abundance estimate is based on model projections from the 2012 survey
b. The 2019 abundance estimate is based on model projections from the 2017 survey

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 western North Atlantic harp seals, based on the last 2017 survey, is 7.6 million (95% CI: 6.5–8.8 million; DFO 2020). The minimum population is 7.1 million. Data are insufficient to calculate the minimum population estimate for U.S. waters due to low sighting rates.

Current Population Trend

Between 1990 and 2017 harp seal pup production has been variable, reaching a high of 1.6 million (SE=117,900) in 2008 (DFO 2020). Estimated pup production in 2017 was 746,500 (95% CI: 570,300–922,700), almost half the number of pups born in 2008 (DFO 2020). The population model used to estimate total abundance from pup production indicates that the population has been relatively stable since 1995 (Hammill *et al.* 2015), declined in 2010 and 2011, but has increased since then, likely due to reductions in removals and high reproductive rates (DFO 2020). There is large inter-annual variability in reproductive rates due to varying rates of late term abortions which appear to be related to changes in capelin abundance, and mid-winter ice coverage (Buren *et al.* 2014; Lewis *et al*. 2019; Stenson *et al.* 2020b; DFO 2020). In the long term, there is uncertainty as to how the changes in ice formation and capelin biomass will affect the reproductive rates of harp seals.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock due to limited understanding of stock specific life history parameters in U.S. waters. Therefore, 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. As there is no resident population of harp seals in U.S. waters, PBR for this stock is based on the minimum estimate of abundance in Canadian waters. 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 for increasing populations. PBR for the western North Atlantic harp seal is 426,000.

Table 2. Best and minimum abundance estimates for western North Atlantic harp seals (Pagophilus groenlandicus), with Maximum Productivity Rate (R_{max}), Recovery Factor (F_r) and PBR.

N_{est}	CV	N_{min}	F_r	R_{max}	PBR
7.6 million	0.07	7.1 million	1.0	0.12	426,000

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 2015–2019 the total estimated annual human caused mortality and serious injury to harp seals was 178,573. This is derived from three components: 1) 86 harp seals (CV=0.16) from the observed U.S. fisheries (Table 3); 2) an average of 1 stranded seal from 2015–2019 that showed signs of non-fishing human interaction as a possible contributor to the mortality; and 3) an average catch of 178,486 seals from 2015–2019 by Canada and Greenland, including bycatch in the lumpfish fishery (Table 4). Uncertainties in bycatch estimates are small compared to the magnitude of commercial and subsistence harvest in Canada. A potential source of unquantified human-caused mortality is the mortality associated with poor ice conditions due to climate change.

Fishery Information

United States

Detailed fishery information is reported in the Appendix III.

Northeast Sink Gillnet

During 2015–2019, 59 mortalities were observed in the northeast sink gillnet fishery (Hatch and Orphanides 2014, 2015, 2016; Orphanides 2019, 2020). There were no observed injuries of harp seals in the Northeast region during 2015–2019 to assess using new serious injury criteria.

See Table 3 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Northeast Bottom Trawl

Harp seals are rarely observed as bycatch in the Gulf of Maine. A single observed take in 2019 occurred in March in Massachusetts Bay. Fishery-related bycatch rates were estimated using an annual stratified ratio-estimator (Lyssikatos and Chavez-Rosales 2022). See Table 3 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for long-term bycatch information.

Table 3. Summary of the incidental mortality of harp seal (Pagophilus groenlandicus) by commercial fishery including the years sampled (Years), 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	Data Type [a]	Observer Coverage [b]	Observed Serious Injury [c]	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Est. CVs	Mean Annual Mortality
Northeast Sink Gillnet	2015	Obs. Data, Weighout, Logbooks	0.14	0	12	0	119	119	0.34	85 (0.16)
	2016		0.10	0	5	0	85	85	0.50	
	2017		0.12	0	6	0	44	44	0.37	
	2018		0.11	0	2	0	14	14	0.8,	
	2019		0.13	0	34	0	162	162	0.19	
Northeast Bottom Trawl	2015	Obs. Data, Weighout, Logbooks	0.19	0	0	0	0	0	na	1.08 (0.89)
	2016		0.12	0	0	0	0	0	na	
	2017		0.12	0	0	0	0	0	na	
	2018		0.12	0	0	0	0	0	na	
	2019		0.16	0	1	0	5.39	5.39	0.89	
TOTAL										86 (0.16)

a. Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Observer Program. The Northeast Fisheries Observer Program 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 coastal sink gillnet fisheries are ratios based on tons of fish landed. North Atlantic bottom trawl fishery coverages are ratios based on trips.

c. Serious injuries were evaluated for the 2015–2019 period and include both at-sea monitor and traditional observer data (Josephson *et al.* 2022).

Other Mortality

United States

From 2015–2019, 363 harp seal stranding mortalities were reported (Table 5; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 17 November 2020). Nine (2.5%) of the mortalities during this five-year period showed signs of human interaction (2 in 2015, 1 in 2016, 2 in 2017, 0 in 2018 and 4 in 2019), 1 of which with some sign of fishery interaction (2019). One harp seal was reported shot, and in 4 other cases the human interaction could have contributed to the death. Harris and Gupta (2006) analyzed NMFS 1996–2002 stranding data and suggested that the distribution of harp seal strandings in the Gulf of Maine was consistent with the species' seasonal migratory patterns in this region.

Canada

Harp seals have been commercially hunted since the mid-1800s in the Canadian Atlantic (Stenson 1993). Between 2003 and 2010 the harp seal total allowable catch (TAC) in Canada ranged from 270,000 to 330,000 (ICES 2016). After 2005, TACs were set annually to ensure that the population did not decline below a precautionary reference level within a 15 year period (Hammill and Stenson 2007). In 2011, the TAC was raised to 400,000, but no TAC has been announced since 2017. Commercial catches in Canada have remained below 80,000 since 2009 (Table 2b).

Table 4. Summary of the Canadian directed catch and bycatch mortality of Northwest Atlantic harp seal (Pagophilus groenlandicus) by year.

Fishery	2015	2016	2017	2018	2019	Average
Commercial catches[a]	35,382	66,360	81,742	61,022	32,038	55,309
Struck and lost[b]	64,705	67,075	63,686	67,455	63,313	64,733
Greenland subsistence catch[c]	61,767	56,730	48,493	58,614	58,614	56,864
Canadian Arctic[d]	1,000	1,000	1,000	1,000	1,000	1,000
Newfoundland lumpfish[e]	920	518	169	555	541	541
Total	163,774	189,313	195,190	188,646	155,506	178,486

a. ICES 2019
b. Animals that are killed but not recovered and reported. Stenson and Upward 2020.
c. Stenson and Upward 2020
d. Stenson and Upward 2020
e. ICES 2019. Estimates of bycatch in 2019 were not available so the average from 2015–2018 is reported for 2019.

Table 5. Harp seal (Pagophilus groenlandicus) stranding mortalities[a] along the U.S. Atlantic coast (2015–2019) with subtotals of animals recorded as pups in parentheses.

State	2015	2016	2017	2018	2019	Total
Maine	1	4	3	3	3	14
New Hampshire	0	2	0	1	1	4
Massachusetts	17	19 (1)	13 (1)	13	114	176 (2)
Rhode Island	4	3	4	3	20	34
Connecticut	0	1	1	0	12	14
New York	12	1	7	7	59	86
New Jersey	3	1	0	3	8	15
Delaware	0	0	0	2	3	5
Maryland	1	0	0	0	0	1
Virginia	4	1	1	0	0	6

North Carolina	2	2 (1)	2 (1)	0	1	7 (2)
Total	44	34 (2)	31 (2)	32	221	362 (4)
Unspecified seals (all states)	31	13	86	92	80	302

a. Mortalities include animals found dead and animals that were euthanized, died during handling, or died in the transfer to, or upon arrival at, rehab facilities.

STATUS OF STOCK

Harp seals are not listed as threatened or endangered under the Endangered Species Act and the western North Atlantic stock is not considered strategic under the Marine Mammal Protection Act. The level of human-caused mortality and serious injury in the U.S. Atlantic EEZ is below PBR. The status of the harp seal stock, relative to OSP, in the U.S. Atlantic EEZ is unknown, but the stock's abundance appears to have stabilized. The total U.S. fishery-related mortality and serious injury for this stock is very low relative to the stock size and can be considered insignificant and approaching zero mortality and serious injury rate. Based on the size of the population relative to fishery removals, it is expected that the uncertainties described above will have little effect on the status of this stock.

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