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. 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 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.

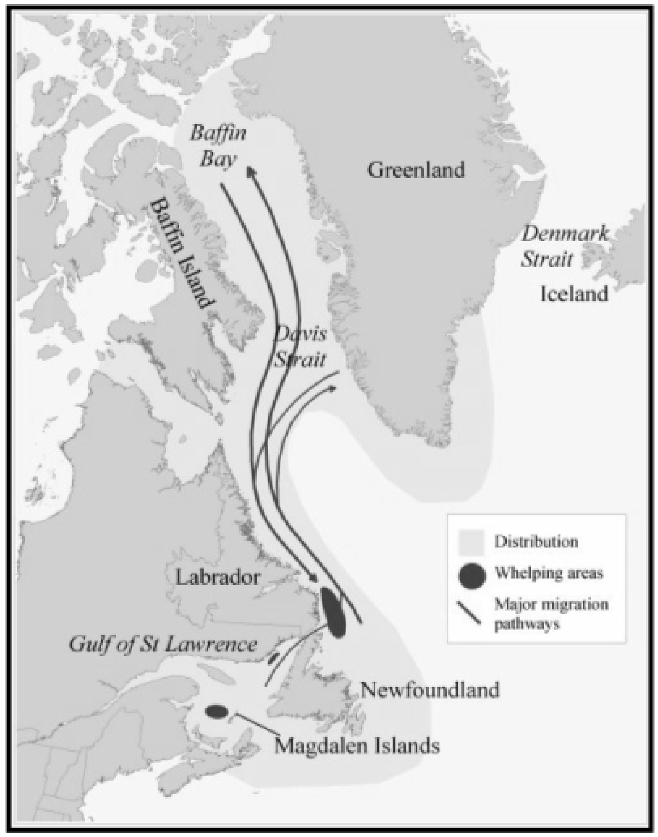

Figure 1: From: *Technical Briefing on the Harp Seal Hunt in Atlantic Canada*

http://www.dfo-mpo.gc.ca/misc/seal_briefing_e.htm

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 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).

POPULATION SIZE

Abundance estimates for the western North Atlantic stock are available which use a variety of methods including aerial surveys and mark-recapture (Table 1). These methods involve surveying the whelping concentrations and estimating total population adult numbers from pup production. 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). This model has subsequently been updated in Shelton *et al.* (1992, 1996), Stenson (1993), Warren *et al.* (1997), and Hammill and Stenson (2011) to consider struck and loss animals, mortality related to poor ice conditions, and variable reproductive rates. A population model was used to examine changes in the size of the population from 1952-2014 (Hammill *et al.* 2014). The model was fit to 12 estimates of pup production from 1952 to 2012, and to annual estimates of age-specific pregnancy rates between 1954 and 2013. Total population size in 2012 was estimated to be 7,445,000 (95% CI: 6.1 to 8.8 million), and projected to be 7,411,000 (95% CI: 6.1 to 8.7 million) in 2014. The population appears to be relatively stable (Hammill *et al.* 2015), though pup production has become highly variable among years (Stenson *et al.* 2014).

Uncertainties not accounted for include variations in reproductive rates as well as changes in mortality due to varying ice conditions.

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_{best}) and confidence interval (CI)

Month/Year	Area	N_{best}	CI
2010	Front and Gulf	8.6-9.6 million	(95% CI 7.8-10.8 million)
2012	Front and Gulf	7.4 million	(95% CI 6.1-8.8 million)
2014	Front and Gulf	7.4 million	(95% CI 6.1 – 8.7 million)

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 is 7.4 million (95% CI 6.1-8.7 million; Hammill *et al.* 2014). Data are insufficient to calculate the minimum population estimate for U.S. waters due to low sighting rates.

Current population trend

Harp seal pup production in the 1950s was estimated at 645,000, but had decreased to 225,000 by 1970 (Sergeant 1975). Estimated production then began to increase and continued to increase through the late 1990s, reaching 998,000 (CV=0.10) in 1999 (Stenson *et al.* 2003). Estimated pup production in 2008 was 1,630,300 (CV=6.8%), but decreased to 790,000 (SE=69,700, CV=8.8%) in 2012 (Stenson *et al.* 2014). This estimate is approximately half of the estimated number of pups born in 2008, likely due to lower reproductive rates in 2012 compared to 2008 (Stenson *et al.* 2014). Uncertainties in fecundity rates as well as uncertainties in ice conditions have potentially large impacts on population trends.

The status of the population in U.S. waters is unknown. Recent increases in strandings may not be indicative of population size.

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. 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. 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 the population is increasing. PBR for the western North Atlantic harp seal in U.S. waters is unknown. The PBR for the stock in U.S. waters is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period 2011–2015 the total estimated annual human caused mortality and serious injury to harp seals was 216,044. This is derived from three components: 1) an average catch of 215,998 seals from 2011-2015 by Canada and Greenland, including bycatch in the lumpfish fishery (Table 2a); 2) 43 harp seals (CV=0.24) from the observed U.S. fisheries (Table 2b); and 3) an average of 3 stranded seals from 2011-2015 that showed signs of non-fishing human interaction. 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

U.S.

Detailed fishery information is reported in the Appendix III.

Northeast Sink Gillnet:

During 2011–2014, 27 mortalities were observed in the northeast sink gillnet fishery (Orphanides 2013, Hatch and Orphanides 2014; 2015; 2016, Orphanides and Hatch 2017). There were no observed injuries of harp seals in the Northeast region during 2011–2015 to assess using new serious injury criteria.

See Table 2b 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

One harp seal mortality was observed in the Northeast bottom trawl fishery in 2011. Annual mortalities were estimated using annual stratified ratio-estimator methods (Chavez-Rosales *et al*. 2017). See Table 2b for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Table 2b. 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	Estimated CVs	Mean Annual Mortality
Northeast Sink Gillnet[e]	11-15	Obs. Data, Trip Logbook, Allocated Dealer Data	.19, .15, .11, .18, .14	0, 0, 0, 0, 0	4, 0, 2, 9, 12	0, 0, 0, 0, 0	14, 0, 22, 57, 119	14, 0, 22, 57, 119	.46, 0, .75, .42, .34	42 (0.24)

Northeast Bottom Trawl[d]	11-15	Obs. Data Weighout	.26, .17, .15, .17, .19	0, 0, 0, 0, 0	1, 0 , 0, 0, 0	0, 0, 0, 0, 0	0, 0, unk, 0, unk	.2.9, 0, 0, 0, 0	.81. 0, 0, 0, 0	0.6 (.81)[d]
TOTAL										43 (0.24)

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 2011–2015 period and include both at-sea monitor and traditional observer data (Josephson *et al.* 2017)

Other Mortality

U.S.

From 2011 to 2015, 279 harp seal stranding mortalities were reported (Table 3; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 13 September 2016). Sixteen (5.7%) of the mortalities during this five-year period showed signs of human interaction (7 in 2011, 1 in 2012, 2 in 2013, 4 in 2014 and 2 in 2015), 1 of which with some sign of fishery interaction (2013). 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). In 2011 the TAC was raised to 400,000 and since then, has remained at this level each year. The TAC includes allocations for aboriginal harvesters (6,840), development of new products (20,000), and personal use (2,000). There is no specific allocation or quotas for catches in Arctic Canada. Commercial catches in Canada have remained below 80,000 since 2009 (Table 2a).

Table 2a. Summary of the Canadian directed catch and bycatch mortality of Northwest Atlantic harp seal (*Pagophilus groenlandicus*) by year

Fishery	**2011**	**2012**	**2013**	**2014**	**2015**	**Average**
Commercial catches[a]	40,389	71,460	90,703	54,830	35,304	**58,537**
Struck and lost[b]	77,156	64,664	86,970	66,946	81,609	**75,469**
Greenland subsistence catch[c]	73,277	59,124	80,102	62,147	68,662	**68,662**
Canadian Arctic[d]	1,000	1,000	1,000	1,000	1,000	**1,000**
Newfoundland lumpfish[e]	12,330	12,330	12,330	12,330	12,330	**12,330**
Total	**204,152**	**208,578**	**271,105**	**197,253**	**198,905**	**215,998**

a. ICES 2016

b. Animals that are killed but not recovered and reported. Values include seals from both Canada and Greenland (ICES 2016).

c. ICES 2016. Catches in 2015 are an average from 2011-2014
d. ICES 2016.
e. Estimates of bycatch levels in the last decade are not available and so the average annual level during the previous decade (12,330) has been assumed (DFO 2014)

Table 3. Harp seal (*Pagophilus groenlandicus*) stranding mortalities [a] along the U.S. Atlantic coast (2011–2015) with subtotals of animals recorded as pups in parentheses.

State	2011	2012	2013	2014	2015	Total
Maine	6	0	2	2 (1)	1	11
New Hampshire	0	0	1	0	0	1
Massachusetts	51 (1)	4	6 (1)	28	17	106
Rhode Island	7	0	1	9	4	21
Connecticut	4	0	0	0	0	4
New York	38 (1)	1	9	18	12	78
New Jersey	16	0	2	1	3	22
Delaware	2	0	1	0	0	3
Maryland	3	0	0	0	1	4
Virginia	5	0	1	9	4	21
North Carolina	3	0	2	1	2	8
Total	**135**	**5**	**23**	**68**	**44**	**279**
Unspecified seals (all states)	63	28	25	38	31	147

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 low relative to the total stock size. 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 low levels of uncertainties described in the above sections, it expected these uncertainties will have little effect on the status of this stock.

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