



STOCK ASSESSMENT OF NORTHWEST ATLANTIC HARP SEALS (*PAGOPHILUS GROENLANDICUS*) IN 2024



Photograph by DFO.

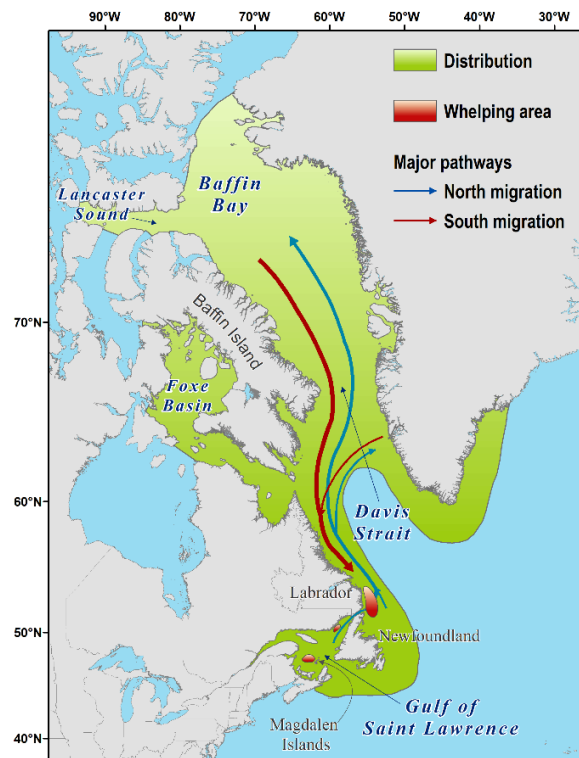


Figure 1. Range, migratory pathways and whelping locations of Harp Seals in the northwest Atlantic.

CONTEXT

The Northwest Atlantic harp seal (*Pagophilus groenlandicus*) population is assessed every 4-5 years. A new pup production survey was completed in March 2022. Resource Management requested that Science provide an update on the population status and trend. They also requested the harvest levels over the next five years that will respect management objectives, assuming an age composition of the harvest of: 5% age 1+ / 95% young of year (YOY), 10% age 1+ / 90% YOY, or 50% age 1+ / 50% YOY.

This Science Advisory Report is from the December 3-6, 2024, national peer review meeting on the Northwest Atlantic Harp Seal (*Pagophilus groenlandicus*) Population Assessment and Harvest Advice for 2025-2029. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

SUMMARY

- The Northwest Atlantic (NWA) harp seal population is hunted throughout its range. Seals are harvested for subsistence purposes in Labrador, Arctic Canada, and Greenland, and a commercial harvest occurs in the Gulf of St. Lawrence and off Newfoundland and Labrador.
- Stock status and harvest advice are provided using an Integrated Population Model which incorporates the periodic estimates of pup production along with updated data on age composition, age-specific reproductive rates, total removals, and environmental conditions.
- Pup production was assessed through photographic aerial surveys conducted between March 5-25, 2022. Total pup production was estimated as 614,100 (SE=69,500, CV=11%) (rounded to the nearest hundred).
- The 2022 pup production estimate is the lowest since 1994.
- Based on the population model, harp seal abundance increased rapidly from the 1970s through the 1990s, peaking at an estimated abundance of 7.5 million seals (95% Credible Interval, CrI: 6.75-8.42) in 1998. The population declined from 1998-2024 with the exception of a period of relative stability between 2009-2019.
- The estimated 2024 total abundance is 4.4 million seals (95% CrI: 3.65-5.35). This represents a decline in abundance from 2019 (5.6 million, 95% CrI: 4.78-6.63) at a rate of 4.7% (95% CrI: 2.14-7.45%) per year.
- Harp seals are managed under the Atlantic Seal Management Strategy (ASMS). Based upon the current population model, the environmental carrying capacity (K) was estimated to be 6.9 million seals (95% CrI: 5.27-8.48), resulting in a Precautionary Reference Point (PRP, N_{70}) of 4.8 million seals and a Limit Reference Point (LRP, N_{30}) of 2.1 million seals.
- The estimated 2024 total abundance has an 80% probability of being below the PRP and is therefore considered to be in the Cautious Zone.
- Under the revised ASMS, the sustainable harvest levels that ensure an 80% probability of the population increasing above the PRP (N_{70}) in 1.5 generations (30 y) were estimated for the next five years (2025-2029). The annual Atlantic Canadian sustainable harvest levels which meet this criteria are 253,000, 222,000, and 113,000 seals assuming harvest age compositions of 95%, 90%, and 50% young of the year (YOY), respectively.
- Based on the estimated 2024 abundance, the annual Potential Biological Removal (PBR) for the NWA population is 121,800 seals. This value includes removals from all sources including reported harvest, struck and lost (killed but not recovered or reported), and bycatch in Canada and Greenland.
- There is considerable uncertainty in the age structure and level of struck and lost of the subsistence harvest in Greenland. Model results indicate that the Greenland harvest has an important impact on NWA harp seal population dynamics.
- Our harvest projections assume that ice conditions and environmental variables will remain similar to recently observed conditions. Given predicted changes in the environment, we expect a decline in vital rates which could lead to further population decline and lower sustainable harvest levels.

BACKGROUND

The Northwest Atlantic (NWA) harp seal population summers in the eastern Canadian Arctic and adjacent waters, and then migrates south during the fall and early winter (Figure 1). Pups are born on the pack-ice off the southeast coast of Labrador/northeast coast of Newfoundland (the Front) and in the Gulf of St. Lawrence (Gulf) during late February and early March. Seals are harvested for subsistence purposes in Labrador, Arctic Canada, and Greenland, and a commercial harvest occurs in the Gulf of St. Lawrence and off Newfoundland and Labrador. They are also caught incidentally in commercial fisheries.

Harp seals require stable ice for whelping and resting. Mortality of young of the year (YOY) can be very high in years when there is limited suitable ice or ice conditions are poor.

The population was last assessed in 2019. New aerial surveys were flown in February-March 2022 to estimate harp seal pup production in the Gulf and at the Front. Annual data on reproductive rates, age structure, total removals, and environmental conditions were also updated. These data were incorporated into an integrated population model to generate estimates of total abundance, and future abundance trends assuming different age compositions of the harvest and future environmental conditions.

NWA harp seals are managed as a Data Rich population under the Atlantic Seal Management Strategy.

ASSESSMENT

The population model relies on six sources of data:

1. pup production estimates,
2. reproductive rates,
3. age composition,
4. human removal numbers (harvest and bycatch, Figure 2),
5. ice anomalies in the Gulf and at the Front, and
6. the Newfoundland and Labrador Climate Index (NLCI).

The latter two data sets represent co-variates for vital rates, while the first four data sets represent observations used for model fitting.

Photographic aerial surveys were flown in the Gulf and at the Front to estimate total pup production in March 2022. Estimated total pup production was 614,100 (SE=69,500, CV=11%) (rounded to the nearest hundred). This is the lowest estimate since 1994 (Figure 3).

Information on age-specific reproductive rates was based on seal ovaries collected around Newfoundland and southern Labrador (Figure 4). Age composition data for males and females was obtained from seals collected from October through February for reproductive rates or as part of other sampling programs carried out by DFO (1979-2022) (Figure 5). Only seals five years of age and older were used for model fitting due to concerns about potential sampling biases for the youngest age classes.

Environmental conditions have varied considerably over the time series. Negative ice anomalies were associated with significant increases in YOY mortality, especially at the Front (Figure 6). There is a negative relationship between the Newfoundland Climate Index (NLCI) and pregnancy rates and YOY survival (Figure 6).

Model-based estimates of total removals matched well with observations (Figure 7). The model showed several shifts in the composition of removals across time. In recent years, the proportions of YOY and adults (defined as seals 1 year of age and older) in total removals were relatively similar (Figure 7). This is because, since 2009, removals in the Atlantic Canadian hunt, which is mostly directed towards YOY, have declined while the Greenland hunt, which is mostly directed towards adults, has remained relatively stable (Figure 2).

The model indicates that the NWA harp seal population abundance increased rapidly from the 1970s through the 1990s, peaking at an estimated abundance of 7.5 million seals (95% CrI: 6.75-8.42) in 1998. Following a period of decline the population was relatively stable from 2009-2019. The model estimated total abundance for 2024 is 4.4 million seals (95% CrI: 3.65- 5.35). This represents a decline in abundance from 2019 (5.6 million seals, 95% CrI: 4.78-6.63) at a rate of approximately 4.7% (95% CrI: 2.14-7.45%) per year (Figure 8).

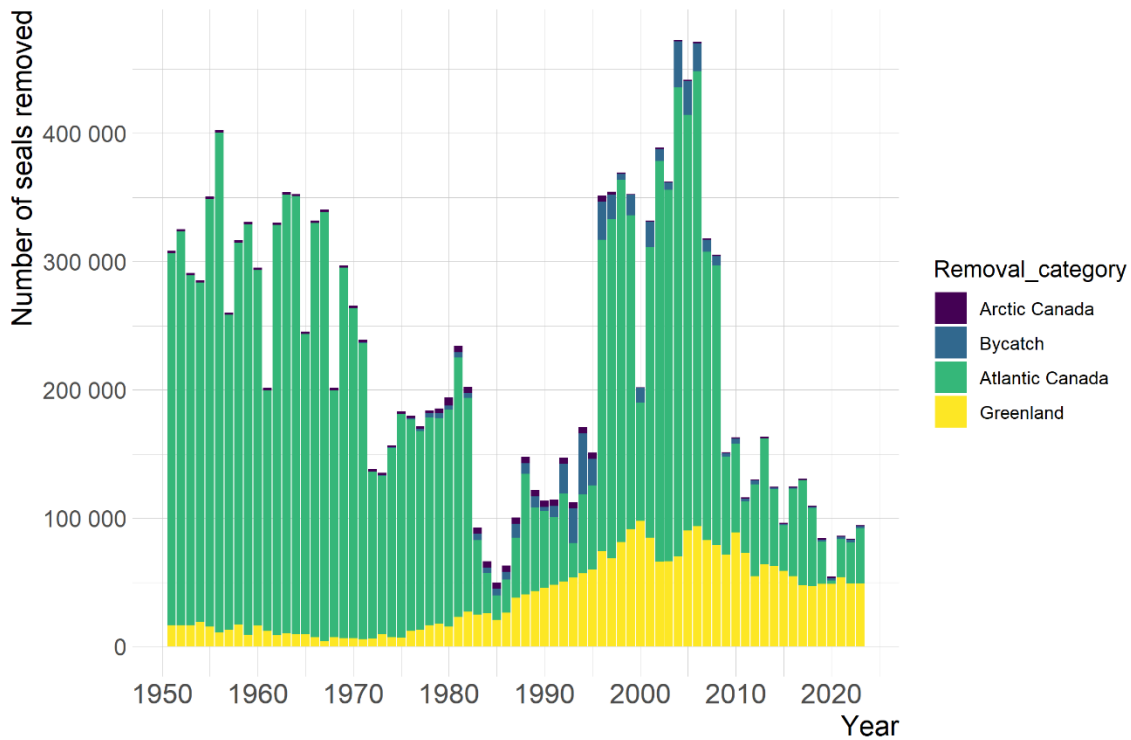


Figure 2. Total removals of NWA harp seals by source for 1952 to 2023.

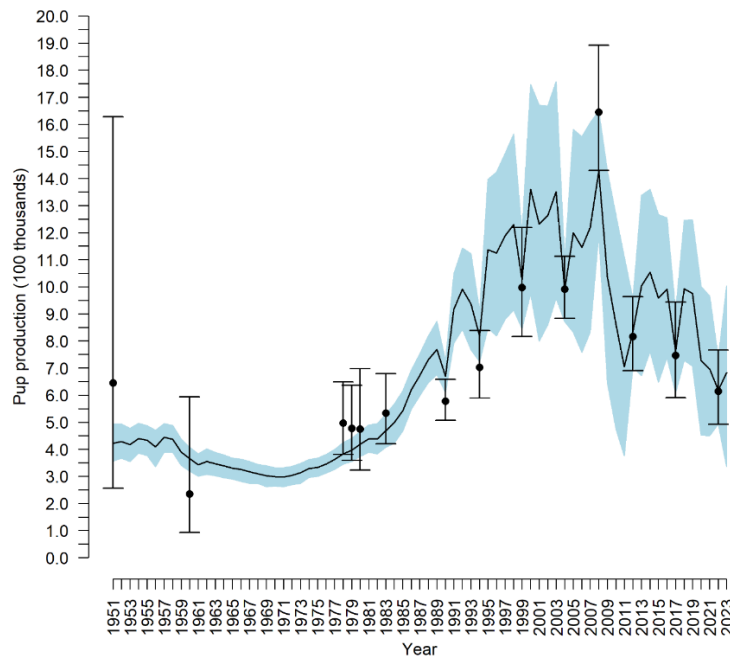


Figure 3. Model-based predictions of total pup production across the time series (line: average prediction; polygon: 95% Credible Interval). Pup production survey estimates with 95% Confidence Intervals are also shown (dots with error bars).

The model showed several shifts in the relative contributions of removals and natural mortality to overall mortality of YOY and adults (Figure 9). Averaged over the entire time series, removals represented the most important source of mortality for YOY. However, density-dependent mortality has increased substantially since 1995, and ice anomalies and climate effects (NLCI) have also accounted for an increasing fraction of YOY mortality since 2000 (Figure 9). Adult mortality is currently dominated by the Greenland harvest (Figure 9).

Under the current Atlantic Seal Management Strategy (ASMS), the maximum population size observed or estimated (N_{max}), was estimated to be 7.5 million seals (95% CrI: 6.81-8.35). This results in a Precautionary Reference Point (PRP, N_{70}) of 5.3 million seals and a Limit Reference Point, (LRP, N_{30}) of 2.2 million seals. At a total estimated abundance of 4.4 million seals for 2024, there is a 96% probability that the NWA harp seal stock is below the PRP and is, therefore, in the Cautious Zone. There is no harvest level that would have an 80% probability of the population increasing above the PRP (N_{70}) in 10 years, which is the timeframe for the Harvest Control Rule (HCR) in the upper portion of the Cautious Zone under the current ASMS.

Under the revised ASMS, the environmental carrying capacity (K) was estimated to be 6.9 million seals (95% CrI: 5.27-8.48). This results in a Precautionary Reference Point (PRP, N_{70}) of 4.8 million seals and a Limit Reference Point, (LRP, N_{30}) of 2.1 million seals. At a total estimated abundance of 4.4 million seals for 2024, there is an 80% probability that NWA harp seals are below the PRP and are, therefore, in the Cautious Zone. Projecting forward (assuming ice conditions remain similar to recently observed conditions), the sustainable harvest levels for the next five years (2025-2029) that will have an 80% probability of the population increasing above the PRP (N_{70}) in 1.5 generations (30 y) were estimated for harvest age compositions of 95%, 90% and 50% YOY, respectively (Table 1).

Table 1. The annual Atlantic Canadian sustainable harvest levels that would have an 80% probability of the population increasing above the PRP (N_{70}) in 1.5 generations (30 y) for different age compositions of the harvest (young of the year, YOY, and adult seals (1 year of age or older)) under the revised ASMS.

Harvest composition	Harvest Level
95% YOY/5% Adults	253,000
90% YOY/10% Adults	222,000
50% YOY/50% Adults	113,000

The annual Potential Biological Removal (PBR) estimate for the NWA harp seal stock was 121,800 (rounded to the nearest hundred). This was calculated using an estimated minimum population size for 2024 (N_{min}) of 4.1 million seals, a recovery factor (F_R) of 0.5 and the default maximum rate of population increase (R_{max}) of 12% for pinnipeds. This value includes removals from all sources including reported harvest, struck and lost (killed but not recovered or reported), and bycatch in Canada and Greenland, and assumes that the age and sex composition of the harvest match those of the population.

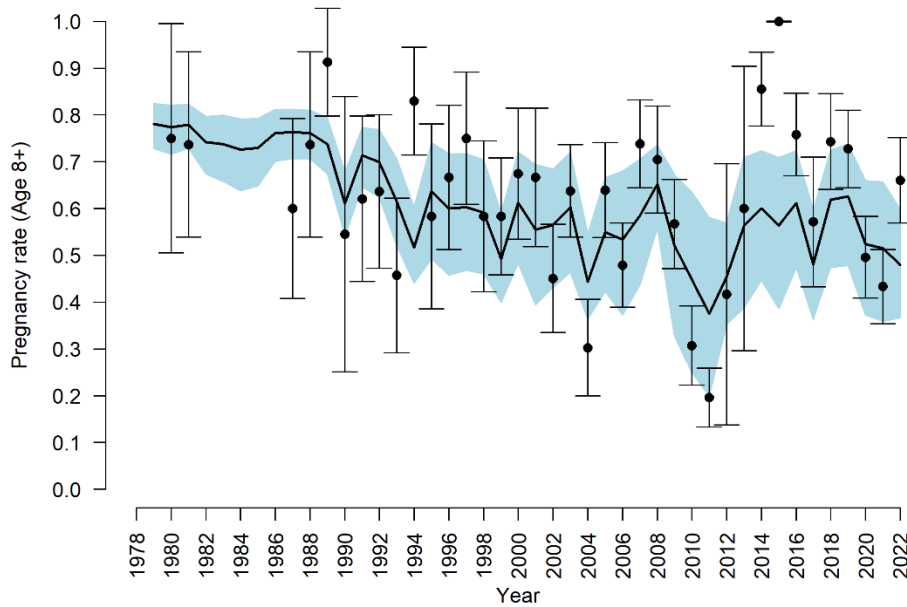


Figure 4. Model-based predictions of reproductive rates for individuals age 8+ across the time series (line: average prediction; polygon: 95% Credible Interval). Observations with 95% Confidence Intervals are also shown (dots and bars).

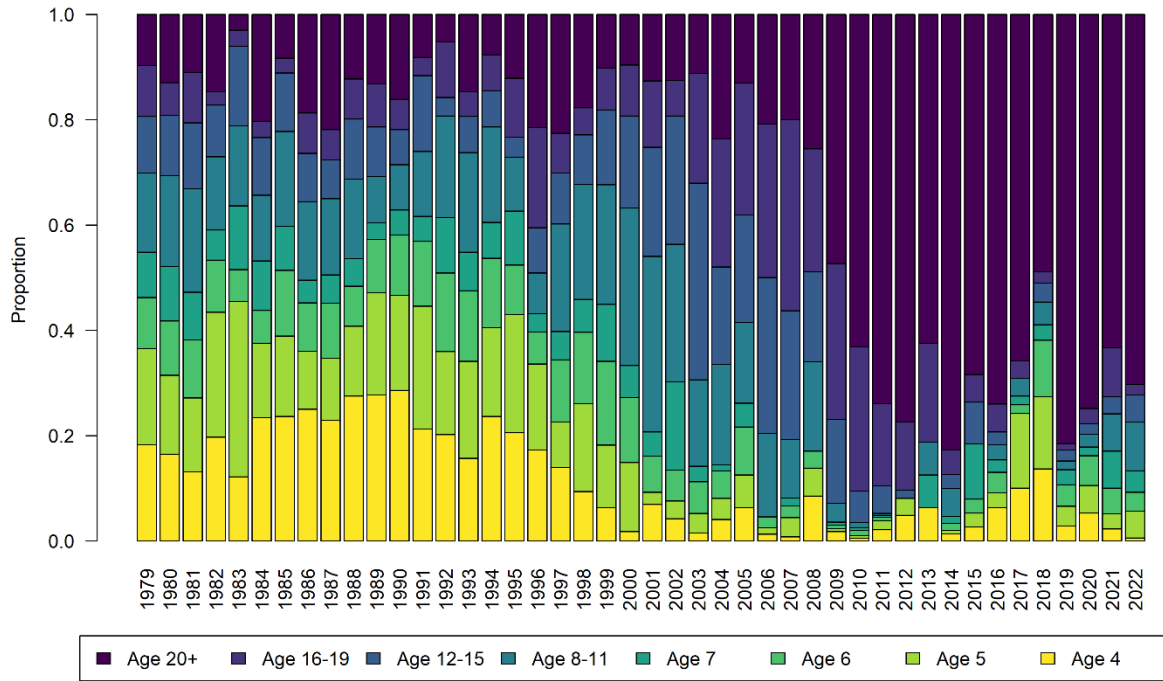


Figure 5. Proportion of samples comprised of different age classes (years) collected by year between 1979-2022. Only ages ≥ 5 are used in the integrated population model.

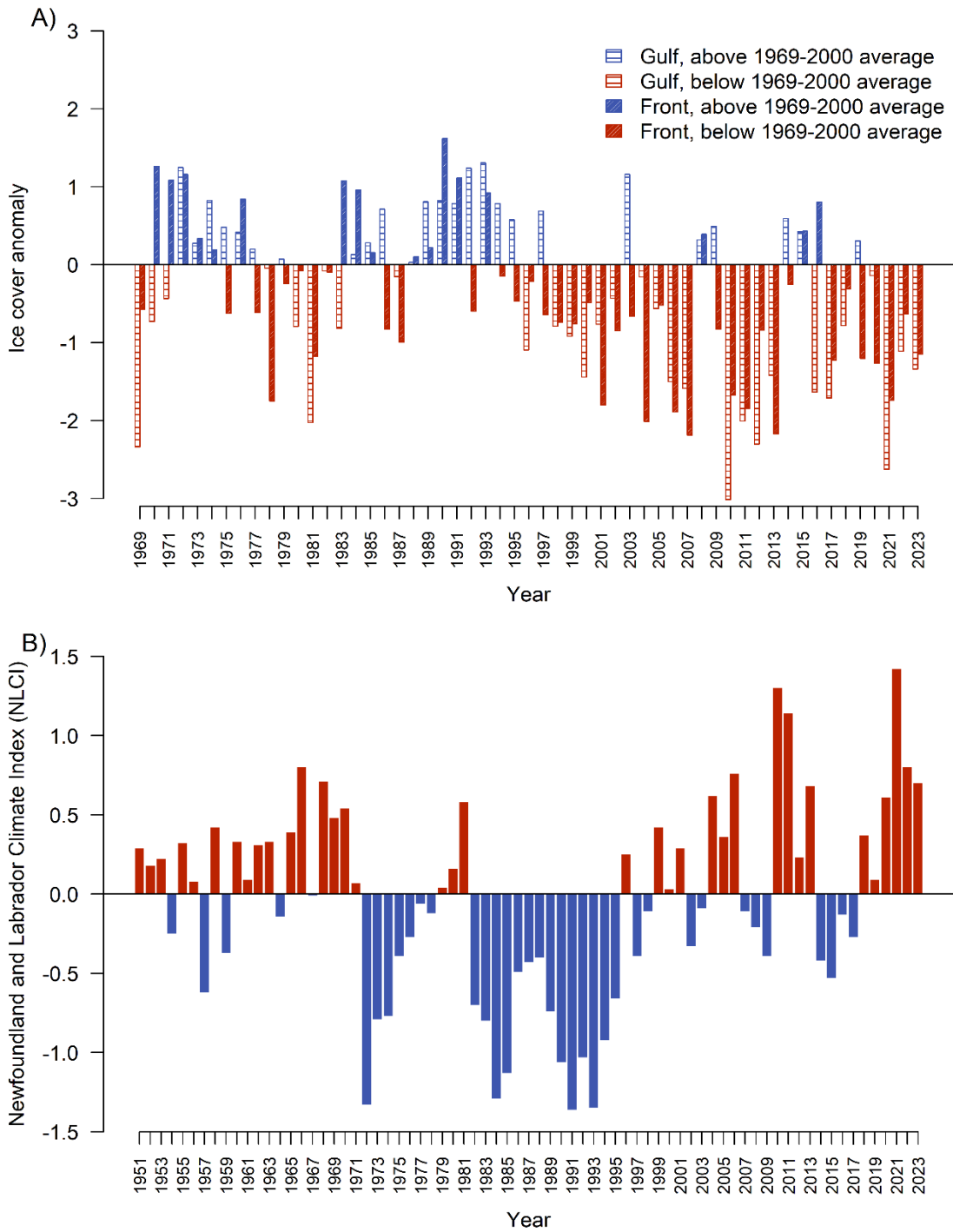


Figure 6. A) Ice anomalies for the Gulf of St. Lawrence (Gulf) and the southeast coast of Labrador/northeast coast of Newfoundland (Front) using the mean first-year ice cover for 1969-2000 as the baseline. B) Newfoundland Climate Index (NLCI) for 1951-2019.

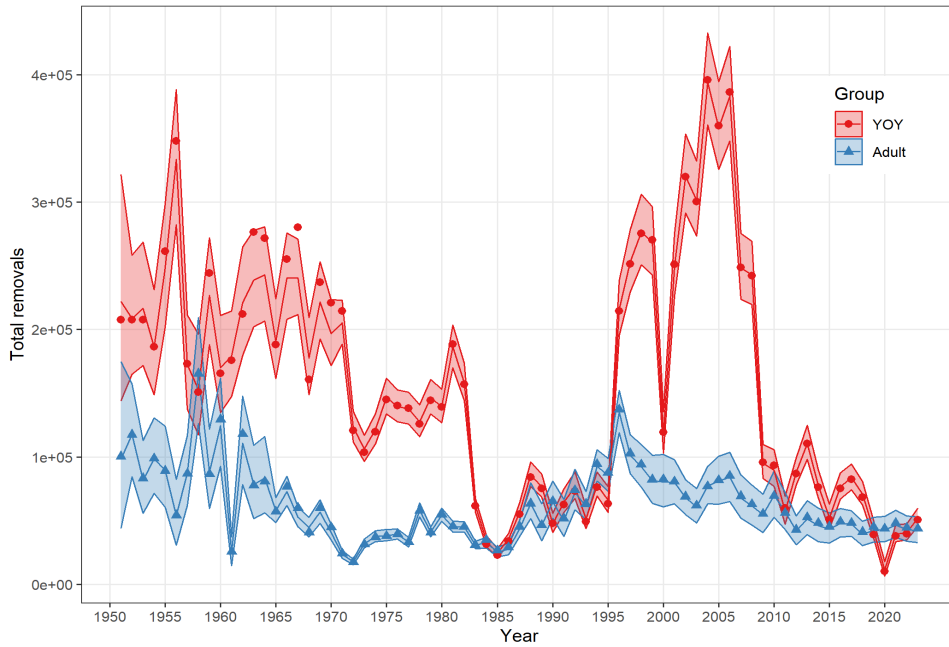


Figure 7. Model-based estimate of total removals of young of the year (YOY; red) and adult (1+ year-olds; blue) NWA harp seals (line: average prediction; polygon: 95% Credible Interval). Observations are also presented (dots).

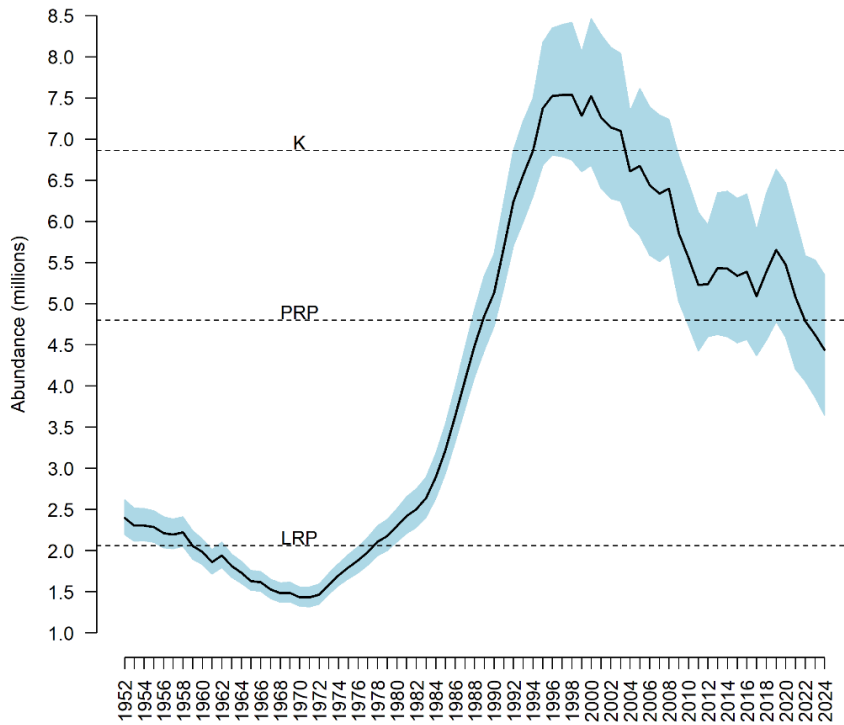


Figure 8. Model-based estimates of NWA harp seal population abundance across the time series (line: average estimate; polygon: 95% Credible Interval). K, environmental carrying capacity. LRP, Limit Reference Point (N_{30}). PRP, Precautionary Reference Point (N_{70}).

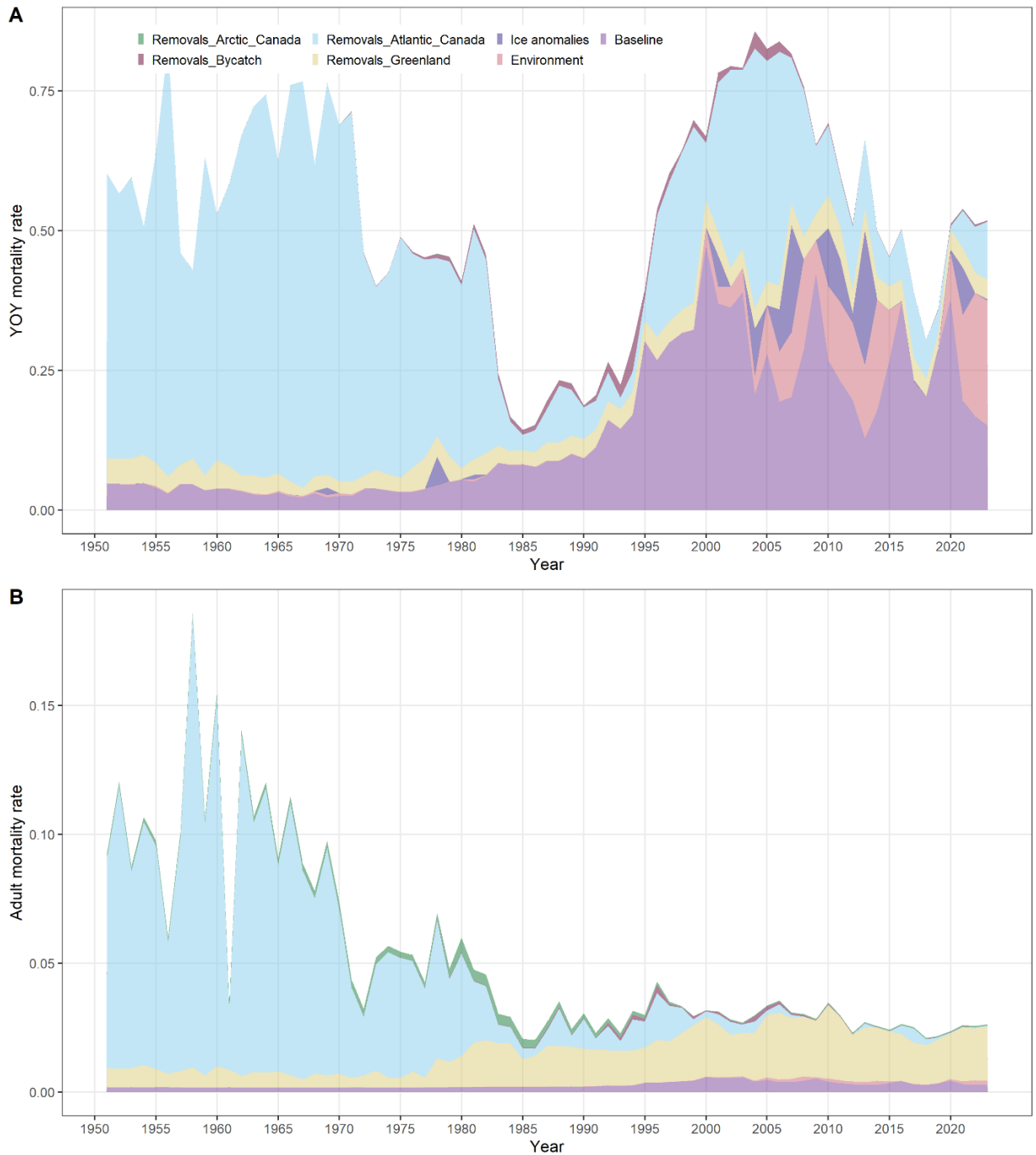


Figure 9. Contributions of different sources of mortality to the total annual mortality rate of (A) young of the year (YOY) and (B) adult NWA harp seals.

Sources of Uncertainty

There is considerable uncertainty in the age structure and level of struck and lost for the subsistence harvest in Greenland. Model results indicate that the Greenland harvest has an important impact on NWA harp seal population dynamics through its impact on adult mortality.

Our harvest projections assume that ice conditions and environmental variables will remain similar to recently observed conditions. Given predicted changes in the environment, this may result in further declines in vital rates which could lead to continued population decline and lower sustainable harvest levels.

CONCLUSIONS AND ADVICE

Based on an integrated population model that included pup production estimates up to 2022, and updated data on age composition, age-specific reproductive rates, total removals, and environmental conditions, the estimated 2024 total abundance of NWA harp seals is 4.4 million (95% CrI: 3.65- 5.35).

The estimated 2024 total abundance has an 80% probability of being below the PRP (N_{70}) and, therefore, the NWA harp seal stock is considered to be in the Cautious Zone. Under the revised ASMS and assuming bycatch, and catches in Arctic Canada and Greenland remain at their current levels, the annual Atlantic Canadian sustainable harvest levels for 2025-2029 that ensure an 80% probability of the population increasing above the PRP in 1.5 generations (30 y) are 253,000, 222,000, and 113,000 seals assuming harvest age compositions of 95%, 90%, and 50% YOY, respectively.

The population has been declining in recent years likely due to increases in the natural mortality of YOY resulting from environmental conditions (ice anomalies and NLCI) and density-dependent factors, the larger proportion of adult (age 1+) harvested in Greenland compared to Atlantic Canada, and an age structure which is skewed towards older individuals.

The impact of different harvest scenarios was examined. Population trajectories and the impact of different levels of removals on the population are sensitive to assumptions concerning environmental conditions, particularly future trends in ice conditions, and predicted removals in the Greenland hunt.

OTHER CONSIDERATIONS

Regional ice models predict future declines in ice cover and changes in the timing of ice formation and retreat which would, in turn, be associated with a predicted increase in the ice related mortality of YOY. However, as has been observed previously, if suitable ice is absent in the traditional whelping locations individuals may move to areas where suitable ice is present. Thus, harp seals may adapt to declining ice conditions in the Gulf and at the Front by shifting whelping farther north. At the same time, a northward shift in the whelping areas may increase exposure to other sources of mortality such as predation by polar bears or alter access to seasonal food resources. Changes in the timing of ice formation and retreat may also impact prey availability, and hence, the reproductive rates of harp seals.

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**Stock Assessment of Northwest Atlantic
Harp Seals in 2024**

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ISSN 1919-5087

ISBN 978-0-660-75766-7 Cat. No. Fs70-6/2025-006E-PDF

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Correct Citation for this Publication:

DFO. 2025. Stock Assessment of Northwest Atlantic Harp Seals (*Pagophilus groenlandicus*) in 2024. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2025/006.

Aussi disponible en français :

MPO. 2025. Évaluation des stocks de phoques du Groenland de l'atlantique nord-ouest (*Pagophilus Groenlandicus*) en 2024. Secr. can. des avis sci. du MPO. Avis sci. 2025/006.